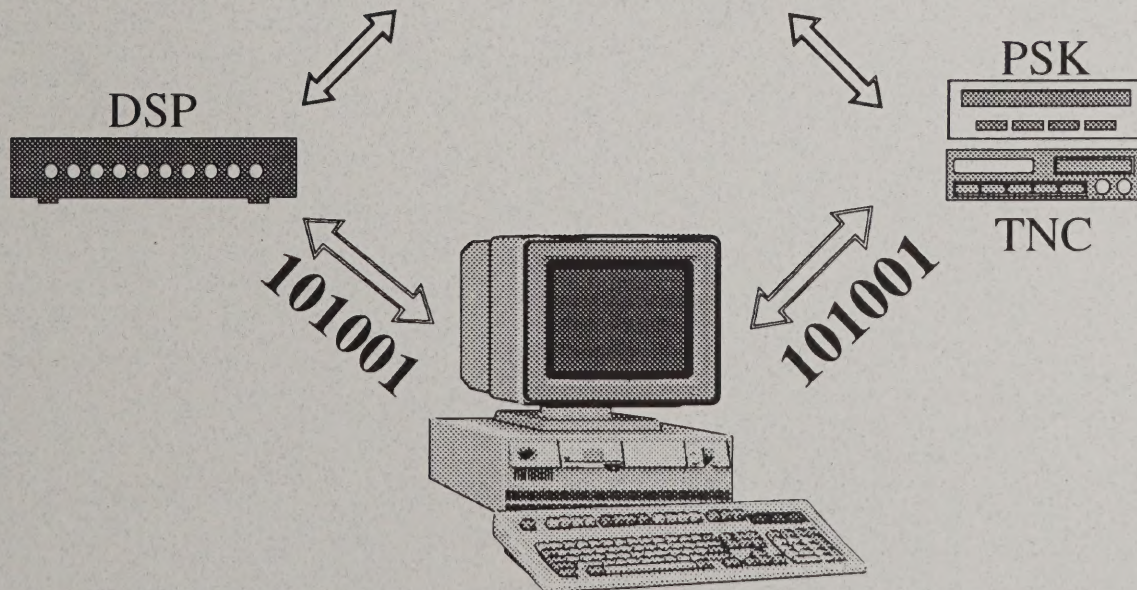
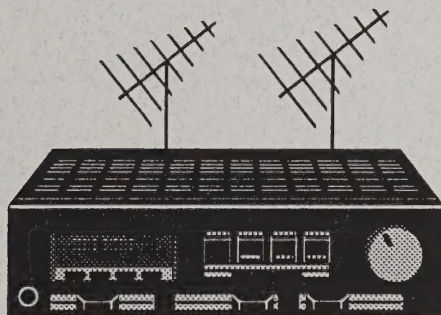
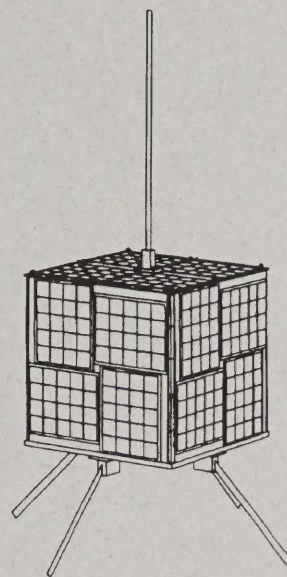
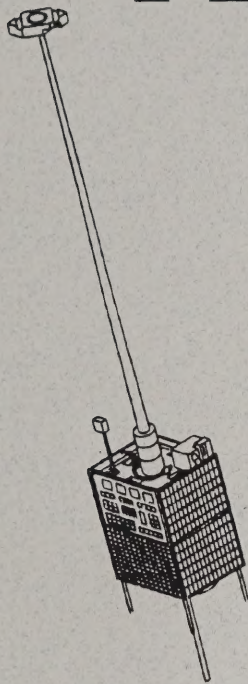
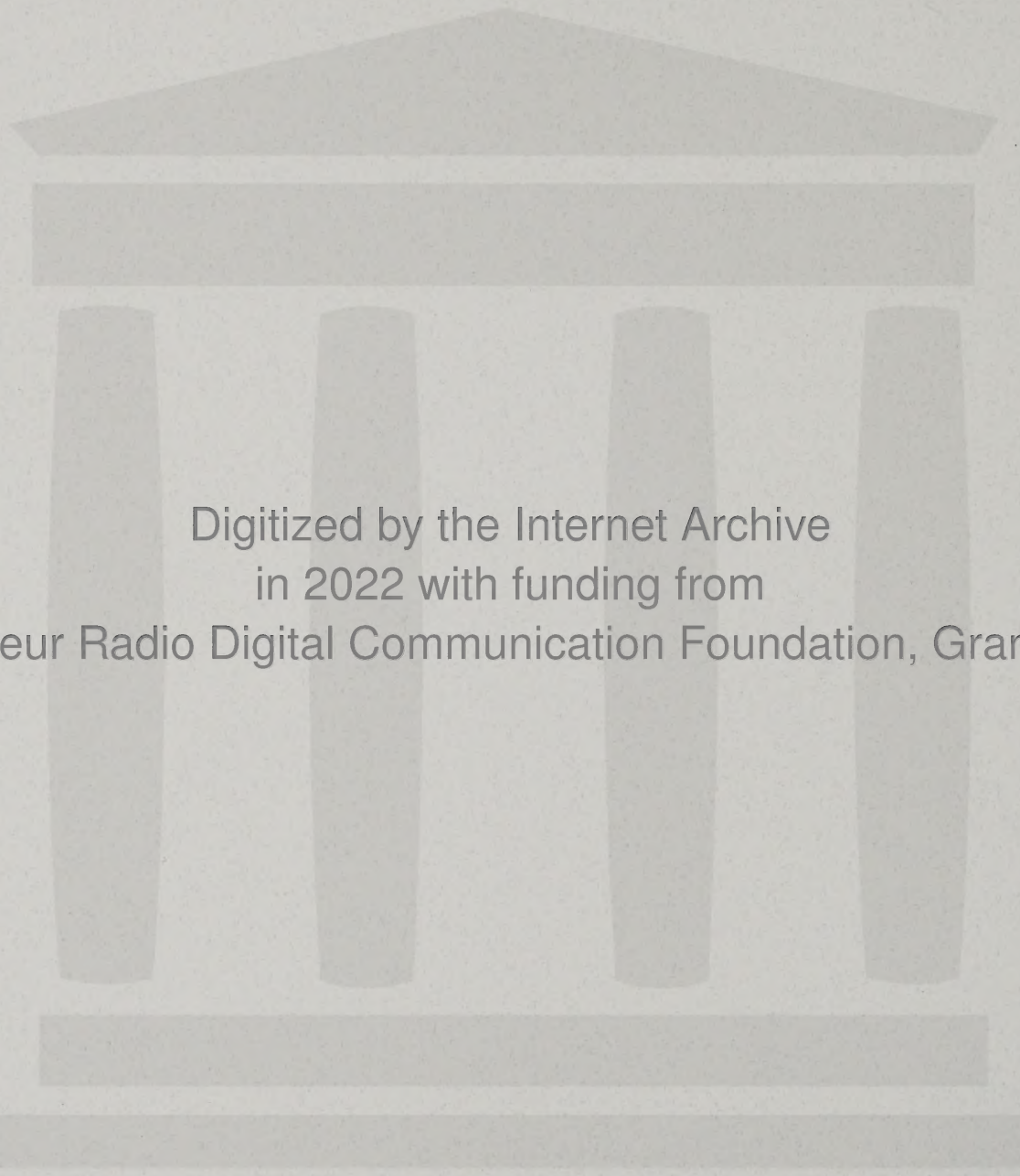


The AMSAT-NA Digital Satellite Guide





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The AMSAT-NA Digital Satellite Guide

Special Dayton 1994 Edition

by

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I. Introduction to the Amateur Digital Satellites

Welcome to the world of digital communications, amateur satellite style. The digital modes are currently the pervasive mode on the amateur satellites. Nearly all of the functional amateur satellites transmit digital data. Now is the time to start learning about these systems, otherwise you will have a great deal more information to assimilate in the future. Satellite digital signals allow very efficient use of the amateur radio spectrum. It is much faster and more reliable (has less error) and than other modes of communications. Other modes may excel in one field, i.e. power, equipment simplicity or ease of use, but the reliability and speed are compromised.

Digital operations on the satellites encompass much more than 'E-MAIL'. There are excellent photographs of the home planet, interesting experimental data, telemetry, utility files and even voice mail. Becoming operational on the digital satellites provides an excellent opportunity to fine tune your satellite system, to investigate many new fields and to challenge you to improve your satellite skills.

If you are new to digital satellite operation or haven't tried the new satellites yet, setting up a digital downlink station is the place to begin. This causes the minimum impact on your station and your pocketbook. Most of the operation of the digital satellites can be mastered while learning the downlink, without interfering with those using the satellite. My observations and hard learned lessons along with those of many other digital satellite operators should make your entry into the world of digital satellites an enjoyable experience. This guide is meant to aid in understanding the required equipment for a digital station, in making your operation easier and improving your problem solving. Once you are confident and comfortable with receiving digital satellite data you can move to part 2, the uplink.

For this effort you will receive self-satisfaction, a great deal of knowledge, additional skills and be a part of the forefront of amateur radio.

Gould Smith, WA4SXM
March 1994

Why digital satellites?

Amateur satellite operators by nature are experimental types, those wanting to try new things. We became interested in using the amateur satellites for various reasons, but their ease of use has never been one of them. The people on the satellites have to work a little harder, learn a little more, and be more self-reliant than those operators that buy a complete, functional system. Many of us enjoy the challenge of learning to master the many areas necessary to reliably operate the amateur satellites at will. A number of voice operators on the satellites have expressed an opposition to the move to digital satellites, but this move or change is in keeping with the objectives of AMSAT. The first issue of the AMSAT Newsletter, June 1969, described the purposes and objectives of the Radio Amateur Satellite Corporation, AMSAT:

- A. Providing satellites that can be used for amateur radio communication and to conduct experiments by suitably equipped amateur radio stations throughout the world on a non-discriminatory basis.*
- B. Encouraging development of skills and the advancement of specialized knowledge in the art and practice of amateur radio communications and space sciences.*
- C. Fostering international goodwill and cooperation through joint experimentation and study, and through the wide participation in these activities on a noncommercial basis by radio amateurs of the world.*
- D. Facilitating communications by amateur satellites in times of emergency.*
- E. Encouraging the more effective and expanded use of the higher frequency amateur bands.*
- F. Disseminating scientific and technical information derived from such communications and experimentation, and encouraging publication of this information in treatises, theses, technical journals or other public means.*

Note that the first objective for AMSAT is to experiment. It is interesting to note that a number of letters to the editor of the AMSAT Newsletter in the late 70's were opposed to satellite experiments using the 430 MHz band. Today the 430 MHz band is the base for almost all of amateur satellite activity. There will always be those that oppose change or acquiring new skills, but the heart of amateur satellite activity is exploration.

The VOLUNTEER satellite designers, builders, testers and assemblers undertake a much more difficult task than the satellite users. Once the device is launched it can't be put back on the bench to correct an oversight - the team must get it right the first time. Those designers on the fore-front of the AMSAT effort, are stimulated by challenge. Once a goal is reached they challenge themselves with a tougher goal. Don't expect more of the same on new amateur satellites. The satellite designers are always 'pushing the envelope' to make the task challenging and interesting.

Digital data formats are in their infancy in amateur radio, expect rapid and far reaching changes during the decade. Once data is in a digital form any number of different operations may be performed upon it. This is a very versatile medium, an experimenters' delight. Digital operation on the satellites IS THE WAVE OF THE FUTURE. Satellite operation is always going to be changing. This is an excellent time to learn about and become part of the revolution in digital communications.

THINGS to KNOW for DIGITAL SATELLITE OPERATION

Becoming operational on most of the digital satellites is NOT simply a matter of connecting three pieces of equipment together, turning them on and working the satellite. But no part of it is difficult - if you are willing to invest some time to learn something new.

Before you begin, you should be able to:

- (1) **operate your computer** (not necessarily to program it), i.e. create directories, move files, copy files and edit text files;
- (2) **read software documentation**, this means to READ it, not to just print it and put it on the shelf;
- (3) **make cables**, obtain connectors and cable, connect and test that the signals are flowing between devices on the correct pins;
- (4) **test serial communications between devices**, i.e. able to determine whether the digital data moving through the serial cable is at the correct data rate;
- (5) **understand TNC commands**, you should have a basic knowledge of the 70 or so commands;
- (6) **be organized**, you must have all the pieces of this system communicating with one another BEFORE the fifteen minute window of the satellite pass; and finally
- (7) **enjoy the challenge of problem solving alone**, its 12:37 am and you are trying to determine why no data is displayed on the computer screen when you are hearing it fine.

This list is not meant to discourage you, just to give you a general idea of what kind of knowledge will be necessary as you progress with the Amateur Digital Satellites. If you can find an ELMER to assist you, great. Most of us have had to do much of this on our own, and that is why much of that knowledge is being shared with you in this publication.

General Information About the Digital Satellites

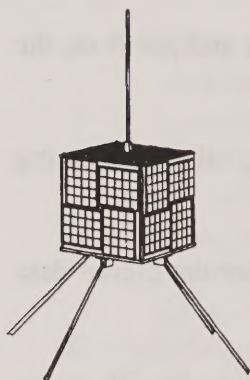
The current assembly of 13 or so self-contained amateur digital satellites share a number of characteristics. They are:

- small satellites,
- built by volunteers,
- in a sun synchronous, low earth, polar orbit,
- able to operate with low power and
- built with experimental digital modes.

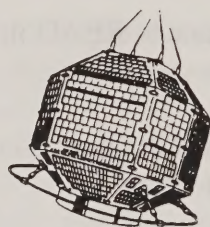
AO-21(RS-14) rides aboard a Russian GEOS research satellite, but contains the most versatile array of digital functions, and has the most powerful transmitter as it derives power from the main satellite system.

SIZE

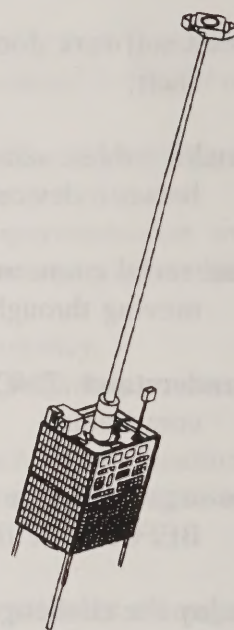
The amateur digital satellites range in size and shape from the Microsats [cubes 9"(23 cm) on a side] to the rectangular boxes of the UoSATS and Kitsats [14"x14"x24" (35cm x 35 cm x 60 cm)] to the 26-sided Fuji orb. All of them weigh about 100 pounds(45-50 kg).



DOVE



FO-20



UoSAT-5

ORBIT

The amateur digital satellites orbit is nearly circular (eccentricity around 0.0008). By comparison, the highly elliptical orbit of AO-13 has an eccentricity of about 0.7209 . Table 1. shows some representative orbital characteristics from the main groups of the amateur digital satellites. Note the relationship of the eccentricity to the small range of change in the satellites altitude, especially FO-20. The inclination is the angle that the satellite's path makes with the equator as it crosses going South to North. A true polar orbit has a ninety degree inclination and places the orbit directly over the North and South Pole. Note that the digital satellite orbits are generally about ± 8 degrees off a perpendicular orbit. This inclination is chosen to place the satellite in a sun synchronous orbit. See Figure 1.

Their orbits are relatively close to the earth, between 800km and 1700km above the earth, this is why they are known as LEO (Low Earth Orbit) satellites. They are also low power devices, less than 5 watts. AO-21 is an exception in that it is piggybacked on a large commercial satellite it is able to provide up to 100 watts of output power. A more through discussion about satellite orbits can be found in Martin Davidoff's A Satellite Experimenter's Handbook, a must for your satellite library. Available through AMSAT and all ARRL publications outlets.

As you would expect, sun synchronous essentially means in sync with the sun. This type of orbit allows maximum solar illumination for battery charging and regular schedules. The satellite will pass over a location at approximately the same sun time each day. As the sun time changes so do the pass times. Daylight savings time introduces an additional offset for people time down here on the ground. But you can count on 2-3 passes in the morning and 2-3 at night. The number varies depending upon how far East or West of your QTH the sub-satellite point passes.



Figure 1. LEO 82° inclination orbit

Table 1. Sample digital satellite orbital parameters

<u>Satellite</u>	<u>Altitude km</u>	<u>Altitude mi</u>	<u>eccentricity</u>	<u>inclination</u>	<u>period</u>
AO-16	790 ±10	474 ±6	0.0011	98	100 min
FO-20	911 - 1740	547 - 1044	0.0540	99	112 min
AO-21	975 ±25	585 ±15	0.0030	82	104 min
UO-22	768 ±6	461 ±4	0.0008	98	100 min
KO-23	1315 ±4	789 ±2	0.0004	66	111 min
KO-25	800 ±7	480 ±4	0.0009	98	100 min

Optimum passes (those with the longest access time above 10° elevation) are those that pass about 27° East on the first pass and about 27° West on the next pass. From the data in Table 2 for the 28DEC93 pm passes, there is nearly 28 minutes of solid access available for the two consecutive passes. Although the three passes on 27DEC93 offer a total of 35 minutes, a great deal of this time is at very low elevation angles, close to the horizon. If you live in populous area, a great deal of noise is often present at low elevation angles, making copy of the digital signals more difficult. Passes that go close to overhead have a pass on either side of the overhead on, but at low maximum elevation angles. Unless you live in an quiet RF area, the higher passes are better.

Table 2. Sample QuikTrak Schedule information

SCHEDULE FOR SATELLITE KO-25 FOR Knoxville, TN

DATE	AOS	MAX	LOS	EPOCH	DX/EL	AZ	ORBIT
27DEC93	143245	143647	144048	27DEC93	4 EL	87	1321
27DEC93	160935	161712	162449	27DEC93	64 EL	96	1322
27DEC93	175010	175621	180232	27DEC93	15 EL	297	1323
28DEC93	014947	015448	015950	28DEC93	8 EL	58	1328
28DEC93	032555	033327	034059	28DEC93	74 EL	74	1329
28DEC93	050753	051337	051922	28DEC93	11 EL	270	1330
28DEC93	154300	155016	155731	28DEC93	34 EL	96	1336
28DEC93	172250	172948	173646	28DEC93	26 EL	292	1337
29DEC93	012525	012826	013127	29DEC93	2 EL	54	1342
29DEC93	025921	030640	031400	29DEC93	40 EL	70	1343
29DEC93	043944	044629	045314	29DEC93	21 EL	266	1344

The satellite footprint, or the earth area that is within view of the satellite, is a circle about 4000 miles (6666 km) in diameter. As you can see in Figure 2., almost the entire North

American continent has access to AO-16 at the same time, and this is the digital satellite with the smallest footprint.

Figure 2. Representative Footprint of AO-16, from QuikTrak



As noted before, most of the LEO satellites have an inclination close to 90° . An inclination of 98° means that the satellite's orbit is 8° past perpendicular with the equator, or west of the North Pole 8° . The earth turns under the satellite's orbit. So, in the 100 minutes or so that the satellites take to complete an orbit around the earth, the earth turns about 28° E. The morning North to South pass of UO-22 over North America turns into a South to North pass for India and central Russia, where it is evening. Since nearly all of these satellites were secondary payloads and have no fuel with which to change their orbit, the inclination is determined by the specified inclination of the primary payload. The AMSAT organizations try to schedule both an inexpensive ride as well as a polar orbit launch. During each 13 hour period, every location in the world has access to each of the digital satellites. Files or messages sent to stations West of the originating station can be delivered quite quickly. Understandably, stations $30\text{--}35^\circ$ East of the originating stations, just out of the simultaneous footprint, have the longest wait.

<u>satellite</u>	<u>AM pass</u>	<u>PM pass</u>
AO-16	N - S	S - N
UO-22	N - S	S - N
KO-23	N - S	S - N
KO-25	N - S	S - N
FO-20	S - N	N - S
AO-21	S - N	N - S

Experimental Digital Modes

With such a grand footprint, a large number of digital satellite operators try to access the satellites at the same time. This was the reason for the development of the PACSAT Protocol. You have all noticed how long it takes for someone to read the new file list on a terrestrial

packet BBS, not to mention reading a file or two. A system like this would only allow one or two users per pass on a digital satellite. To maximize the usage of the digital satellites as they make their 12-18 minutes passes overhead, Jeff Ward, G0/K8KA and Harold Price, NK6K devised the PACSAT Protocol Suite. This software directs your computer to automatically update your current directory and download files you have chosen. You (the operator) basically aren't in the loop to slow the system down. Different portions of the satellite's directory are periodically broadcast using the "Directory Broadcast Protocol". The PB program will update the current satellite directory on your computer. When you select files that you are interested in downloading, the PB program will transmit your request to the satellite. If there is room in the transmit queue, your request is added to the queue. Each file request in the queue is allocated a fixed time period in which to download as many blocks of the file as possible. Then the next request is serviced, and each of the other requests in turn until it is back to your request. The real beauty of the system is that if someone else is requesting the same file, your computer also stores these file blocks at the same time, thus giving everyone a very efficient throughput. When you want to upload files, so simply prepare them BEFORE the pass and run the PG program, and it takes care of uploading the file(s). The PG program uses a File Transfer Protocol known as ftl0. This protocol is used for "connected" satellite communications. This File Transfer Protocol uses AX.25 connected mode. For further information on the various Pacsat Protocol definitions, see the "Proceedings of the ARRL 9th Computer Networking Conference", Ontario, September 1990, pps 203-252.

(These papers can be obtained from the ARRL, RSGB and many ARRL publication outlets).

The automatic transfer functions of the PB/PG programs seem to offer an interesting opportunity to try to automate your station for uploading and downloading. It is possible and a number of people have completely automated their stations to handle traffic while they are away. Dieter, KX4Y describes his automated 9600 bps station in section X, 'The Automated Station'.

The Active Amateur Digital Satellites 4/94

UO-11	1200 bps AFSK hexadecimal, ASCII, mailbox, telemetry, experimental data,
AO-16	1200 bps PSK mailbox, telemetry, bulletins
DO-17	1200 bps AFSK telemetry, bulletins
WO-18	1200 bps PSK earth photos, experimental data, telemetry, bulletins
LO-19	1200 bps PSK mailbox, telemetry, bulletins
FO-20	1200 bps PSK telemetry, BBS, bulletins
AO-21	400,1100,1200,4800,9600 bps PSK & AFSK bulletins, telemetry, mailbox
UO-22	9600 bps AFSK high resolution earth photos, mailbox, telemetry, experimental data
KO-23	9600 bps AFSK high resolution earth photos, mailbox, telemetry, experimental data
PoSAT	9600 bps AFSK mailbox, telemetry, experimental data
KO-25	9600 bps AFSK high resolution earth photos, mailbox, telemetry, experimental data
IT-26	1200 bps PSK, 1200 bps AFSK, 9600 bps AFSK
EYESAT	300-9600 bps
PoSAT	9600 bps AFSK
MIR	1200 bps AFSK FM mailbox
SAREX	1200 bps AFSK FM mailbox

Amateur Digital Satellites, Modes and Frequencies

satellite	downlink frequency Mhz	downlink mode	bdcstcall downlink ID	uplink frequency MHz	uplink mode	bbscall uplink ID
UO-11	145.825 435.025 2401.500	FM FM FM	UoSAT-2 UoSAT-2 UoSAT-2	n/a	n/a	n/a
AO-16	435.050 " " " 437.025 2401.143	SSB SSB SSB SSB SSB SSB	PACSAT-11	145.900 145.920 145.940 145.960 same as above same as above	FM FM FM FM	PACSAT-12 PACSAT-12 PACSAT-12 PACSAT-12
DO-17	145.825 2401.2205	FM SSB	DOVE	n/a	n/a	n/a
WO-18	437.102 437.075	SSB SSB	WO-18	1265.00	AM	
LO-19	437.125 " " " 437.150	SSB SSB SSB SSB SSB	LUSAT-11 LUSAT-11	145.840 145.860 145.880 145.900 same as above	FM FM FM FM	LUSAT-12 LUSAT-12 LUSAT-12 LUSAT-12
FO-20	435.910	SSB	8J1JBS	145.850 145.890 145.910	FM FM FM	8J1JBS 8J1JBS 8J1JBS
AO-21	145.983 " " " "	FM SSB (2400bps) SSB (4800bps) SSB (9600bps) SSB, FM, WEFAX		435.016 435.155 435.193 435.193 435.041	FM SSB SSB SSB RTX-DSP	
UO-22	435.120	FM	UOSAT5-11	145.900 145.975	FM	UOSAT5-12
KO-23	435.175	FM	HL01-11	145.850 145.900	FM FM	HL01-12 HL01-12
KO-25	435.175 436.500	FM FM	HL02-11 same as above	145.870 145.980	FM FM	HL02-12
IT-26	435.867 435.822	SSB SSB	ITMSAT-11	145.875 145.900 145.925 145.950 same as above	FM FM FM FM	ITMSAT-12
AO-27	436.800	FM	EYESAT-11	145.850	FM	EYESAT-12
PoSAT	435.275	FM	POSAT-11	145.925 145.980	FM FM	POSAT-12
Mir	145.55	FM	R0MIR*	145.55	FM	R0MIR*
SAREX	145.55	FM	W5RRR-1*	144.49	FM	

General Digital Satellite Groups

After looking through the list of the digital satellites and the assorted modes in Table 3, where to start can appear an overwhelming task. It is not very practical to attempt to do all of the modes at once. It is best to choose one mode and maybe just one satellite. Then work toward being able to reliably decode the digital data from that satellite. The satellites in Table 3 can be broken down into basically five categories or Groups:

Table 5. General Groups of the Amateur Digital Satellites

DIGITAL A	DIGITAL B	DIGITAL C	DIGITAL D	DIGITAL E	DIGITAL F
1200 bps	1200 bps	1200 bps	9600 bps	1200 bps	400 bps
AFSK, AX.25	PSK, AX.25	PSK, PACSAT	AFSK, PACSAT	AFSK	PSK
		Protocol	Protocol	HEX/ASCII	Hex/ASCII
DOVE	FO-20	AO-16	UO-22	UO-11	AO-13
AO-21	AO-21	WO-18	KO-23		AO-21
MIR		LO-19	KO-25		
SAREX		IT-26	PosAT		

This publication will discuss Groups A, B, C and D. Information on the satellites, data and equipment for those in Groups D and E can be found in the AMSAT publication "Decoding Telemetry from the Amateur Satellites". The Groups increase in complexity from A to D. The satellites in Digital Group A are the simplest, and a good place to begin. You can check out your tracking software, get accustomed to planning for a digital satellite pass and get your first taste of hearing data that sounds good, but not being able to decode it completely. Then add a PSK modem or a DSP communication unit and move up to 1200 bps PSK in Digital Groups B and C. Many newcomers are skipping the Group B and C satellites and going directly to the 9600 bps satellites in Group D. This jump requires modifications to your receiver and transmitter, but will reward you with nice pictures of the earth and eight times the data throughput of Groups B and C.

When assembling the pieces of a digital satellite system, remember that each of these must communicate with the next piece in the link. Optimizing these links will allow you to have the best available digital station. You will expend a great deal of energy and frustrate yourself if you try to put a marginal system together. **Hearing the signal does not mean that you can decode the signal!** Having a system that can reliably decode the digital data gives you a solid foundation upon which to experiment and compare. Without a reliable benchmark system, it is quite difficult to determine which link is marginal. Remember, digital signals from the satellites are sent in packets with error checking, if one bit is interpreted incorrectly the entire packet (100-200 characters) is thrown away. Make sure that your receiver and demodulator have a good signal to work with. Once the data is demodulated correctly, the chances are excellent that you will have no difficult system problems to solve.

Once again, I suggest that you get your station operating very well on the downlink, before attempting to uplink. With the large number of operators accessing the satellite, if you add incorrect RF transmissions to the satellite, you will only decrease everyone's throughput. Please act responsibly in your satellite operation. Pick a goal, become comfortable with your operation and then move to the next Digital Satellite Group.

Configuring Digital Satellite Group Stations

Group A, 1200 bps AFSK station

The satellites in group DIGITAL A need only a 2M FM transceiver, utilize a standard 1200 bps terrestrial TNC and a computer or terminal. Operation is receive only for DOVE or half duplex as

in terrestrial work. So only one 2 meter antenna is needed. A ground plane will work, but to get as much data as possible you need a small beam to track the satellites. Ten to twelve watts out is more that adequate for MIR and SAREX, unless you are competing with hundreds of stations.



DOVE is active again (March 1994) and provides an excellent and consistent source of digital satellite data about six times a day. The signal is strong and you should be able to copy most of the data with a vertical antenna. See section VI, Finding the Digital Satellites - Tracking Software for a through description and some hints in determining the next digital satellite pass. One of the first things you will notice when you begin to receive digital data from the satellites, is that you can hear the DOVE signal well, but your computer screen shows no output. Place your TNC in PASSALL ON mode to see that the TNC is actually decoding some data from the satellite, but getting checksum errors. This can be from normal signal fades as the satellite rolls or a tight squelch setting.

MIR is available quite frequently, but since the cosmonauts work on a Moscow schedule, it is usually inconvenient to match schedules and passes with us in North America. The MIR section in the APPENDIX has more information on the MIR BBS. SAREX operation is occasionally available and discussed in more detail the SAREX section in the APPENDIX .

Group B, 1200 bps PSK station

The satellites in this group have a major change in the way they communicate with the ground stations. The communications are now full duplex. This means that the transmitter and receiver are both active at the same time. It is not practical to have a duplexer on the satellite to allow a 2m uplink and downlink. In fact those of you familiar with them know that they are about the size of the digital satellites. So, to allow full duplex operation the uplink is on 2m and the downlink is on 70 cm. Two antennas are needed to track the satellites for good operation. To operate the satellites in Group B, a major hardware change is necessary to the equipment used in Group A. This is because a different type of modulation is used to encode the SSB downlinked data, Phased Shift Keying (PSK). Either a DSP communication unit can be used to replace the TNC and provide the PSK demodulation or a 1200 bps PSK modem needs to be interfaced to the existing terrestrial TNC. A more thorough discussion of the necessary hardware is found in the DSP, MODEM and TNC sections of Chaper V, 'Considerations on Digital Satellite Equipment'. Another major change is the uplink encoding of the signal. In both groups

the FM uplink data is Manchester encoded. The PSK modems and DSP units take care of both the encoding and decoding. The satellites in Group B and Group C can share the same equipment. More information on the FO-20 BBS is found in the Appendix. The software necessary to operate Digital Group B satellites is only a standard terminal program. WEBERSAT is essentially a downlink only satellite. So it really fits somewhere between Groups B and C. Special software available from AMSAT, WeberWare v3.0 will provide full downlink and decoding of WEBERSAT data.

Group C, 1200 bps PSK station using PACSAT Protocol

The hardware is the same as for Digital Group B. The major change from Group B is the use of the PACSAT Protocol Suite of software to communicate with the satellite. The hardware should be in place, it should simply be a matter of learning to use the software. The software offers many configurations. So there is a good opportunity to learn and experiment with the many available options. WeberWare v3.0 software can use either Group B or C hardware and will allow you to receive earth photographs, telemetry data and experimental data from WEBERSAT and the other Group C satellites. Quite an interesting exercise.

Assembling a 1200 bps Digital Downlink Station

Unless you are an atypical digital satellite operator, you will change your configuration many times. This section will give you a good first time station configuration. As you progress in digital satellite operation you can reread the opinions of the authors of the Digital Satellite Equipment, Section V. After setting up your station, communicating with other digital satellite operators and testing your own theories, I invite you to submit your opinions and experiences for the next edition of the Digital Satellite Guide.

All reliable digital downlink stations are composed of the following basic pieces of equipment:

- pointable antenna;
- preamp;
- receiver;
- DSP unit or PSK modem and TNC;
- computer with serial communications; and
- tracking and digital satellite communication software.

Pointable antenna

As mentioned before, the digital satellites are LEO birds, as such 3-5 watts from the satellite will provide quite a good downlink signal. You will quickly find that a signal that sounds good to your ear often doesn't produce much output on the computer screen. You really can appreciate what a wonderful filter the human ear/brain combination are. A small, three foot 435/437 MHz beam will do quite nicely for reception of the digital signals. The 435/437 MHz beam can easily be mounted permanently to point about 25° in elevation and a small TV rotor used to change the azimuth. Also a small 3-element 2M beam can be added for the uplink.

Many operators have found that it is necessary to add a filter on the 430 MHz line, because the 2m transmission can desense your receive signal. I have found that power and distance between the transmitting and receiving antennas make quite a bit of difference also. Stationary antennas work, but not as well as a beam. It is very difficult to make-up for a noisy signal or wonder why the signal fades so often. Solve this before it is a problem.

Preamp

Use one. An inexpensive, 435/437 MHz preamp can easily be built from scratch or as a kit. Since the 435/437 MHz band is, so far, exclusively used for the digital downlink. No need for the expensive switching relay. Place the preamp on the antenna mast, put a plastic kitchen container over it. Now you can hand the receiver a signal with a very good signal to noise ratio, very capable of being decoded. Many 430 MHz amplifiers have preamps in them. When used inside the shack these will improve your signal, but not as much as a mast mounted preamp.

DSP or TNC/PSK unit

This section may be the most difficult because it describes the part of the system that most aspiring digital satellite operators are the least familiar with. There are two ways to convert the received data to digital data that your computer can interpret.

- (1) a DSP communication unit or
- (2) a PSK modem and a TNC pair.

Before even beginning with digital satellite signals you should be familiar with terrestrial packet operation. This publication is not a magic potion that will teach you what you need to know about digital operation in less than an hour. You should pull out your packet operation guide and READ what each command does. You cannot just change a few parameters to a recommended setting and expect everything to work all the time. You need to understand the purpose and the inter-relationship of most of the TNC commands. Then when you have problem or you are helping someone setup a station you are able to use these commands as tools in solving the problem.

Some of the most useful TNC commands to aid you in improving your downlink are:

frack 2	maxframe 3
paclen 180	pactime after 1
check 3	retry 10
txdelay 20	ackprior off
dwait 0	resptime 0
slots 1	txufram off
start 0	stopo 0

Assembling a 1200 bps Digital Uplink Station

Russ Platt, WJ9F

Many of the components of the downlink station are common to the uplink. These include the DSP unit or PSK modem and TNC, computer with serial communications, tracking and digital satellite communication software. The new station components needed are a separate pointable transmitting antenna, FM transmitter and possibly a power amplifier. Creating a successful uplink station can only be accomplished if you have a reliable downlink station. The uplink signal is Manchester Coded FM. This is different from terrestrial packet AFSK. All the readily available modems to decode this are in orbit. So the only way you really know your uplink works is when the satellite responds to you. Actually a very good way to evaluate your uplink is to simply listen to it on another FM receiver. Adjust your PSK modem output level high at first then decrease it to the level where you first hear a change in the audio. Remember, if you are injecting the transmit signal through the microphone jack of your transmitter and you have a microphone gain control you will have to increase it an appropriate amount so the signal sounds like it did when you adjusted the PSK modem output.

How much power will you need to use for a reliable uplink? This will vary depending on the type of antenna (directional or omni-directional), type of satellite pass (high or low elevation), number of users and if you are varying the uplink frequency for doppler. On high elevation passes with not many users, 5 watts will provide adequate uplink with a directional beam. On low elevation passes with many users using the same uplink channel, 75 to 100 watts will let you be heard. Being patient and waiting for the satellite to answer is a virtue. Remember you cannot hear any of the other uplinking stations so you may be colliding at the satellite receiver. If you are familiar with terrestrial packet commands then probably the easiest satellite to initially connect to is FO-20. I say this because FO-20 will respond to the normal connect-disconnect commands. This satellite is user-interactive. By this I mean that you send it single letter commands and it immediately responds. This can be done with any simple communications program, i.e. PROCOMM. This allows you to check your uplink station performance while learning to setup and practice with PB/PG.

Recommended Operation Procedure to Reduce AO-16 Uplink Contention

Russ Platt, WJ9F

AO-16 Command Team Leader

1993 has brought many new satellites and many new satellite users. I feel it would be good to dust off an old bulletin from 1991 to help refresh the "old-timers" procedures and to acquaint new users to the recommended uplink frequency usage.

The AO-16 Command Team recommends that users of the AO-16 PBBS system use only uplink channel D (145.960 Mhz) for download and directory requests leaving channels A, B, and C (145.900, 145.920, and 145.940 Mhz) for file uploads and digi users.

Stations uploading files should stay off of the download/directory/fill request channel D as their longer uplink packets will collide with the shorter request packets. Stations doing downloads and directories should stay off channels A, B, and C since their frequent but short requests will collide with longer uplink attempts seriously degrading uplink performance. Another benefit of

using this procedure, while most of the uplink activity to AO-16 will be on channel D (145.960) this frequency is high enough in the passband of AO-13 that QRMing our fellow operators will be kept to a minimum when Pacsat crosses beneath AO-13's path.

Recommended AO-16 operating practice in summary:

Downlinks: 437.050 (also 2400.143 on experimenter's day.)

Uplinks: 145.900 A uploads

145.920 B uploads

145.940 C uploads

145.960 D downloads, fills and directory requests

Experimenter's Day Returns to AO-16

AO-16 Command Team Leader, Russ Platt, WJ9F, announces the resumption of Experimenter's Day on Pacsat. In the past Experimenter's Days on Pacsat the procedure was to change to the Pacsat Raised Cosine PSK transmitter on 437.050 Mhz and activate the S-Band transmitter on 2400.143 Mhz. With the decline of the carrier suppression on the "Straight" PSK transmitter (437.025 Mhz) the RC PSK transmitter has become the primary downlink for some time. In the upcoming schedule of Experimenter's Days the power output will be reduced on the RC PSK transmitter and the S-Band transmitter will be turned on. The power output from the S-Band transmitter is not variable so power management is controlled by varying the output of the RC PSK transmitter.

Experimenter's Days managed by AMSAT-NA have been held on UTC Wednesdays since the days of AMSAT-OSCARs 6 and 7 when Wednesday was "battery recharge day." (Incidentally, this is also the reason that the continental U.S. 75 meter nets were originally scheduled for Tuesday evenings.)

Check the AMSAT bulletins for the current schedules.

Group D, 9600 bps AFSK station using PACSAT Protocol

Operation on the 9600 birds is essentially the same as the operation on the Group C satellites. The main difference is how the receive audio and transmit data are attached to the receiver and transmitter. See the following section on 9600 bps Digital Connections. Another difference is in finding the signal. Since the downlink signal is FM and fast (9600 bps) data, you will hear nothing. Actually you will hear things get quieter when you center the signal. It is necessary to use your S meter to find the downlink signal, and tune for a maximum reading. If your receiver has a discriminator setting for the meter (as the FT-726R) this can be used to center the signal. Since the FM downlink signal is so wide, it is not necessary to constantly change the receiver setting as with the satellites in Group B and C. Two or three times during the pass is

adequate. Using PB/PG is exactly the same, only much more data is available, more than 8 times as much. If you grab everything, you can get around 1 Megabyte of data during one pass! Obviously it pays to be more selective on what you receive on these satellites.

9600 bps Digital Connections

9600 bps receiver connections

Nearly all amateur FM receivers filter the received signal after the discriminator removes the audio from the carrier. This filtering removes too much of the 9600 bps data to be used. So it is necessary to take the 9600 bps audio before the filter section. The discriminator section of a receiver looks like this:

9600 bps transmitter connections

The transmitted audio is filtered before it is used to modulate the FM carrier. This filtering also removes too much of the 9600 bps data to make it usable by the satellite. So it is necessary to insert the 9600 baud audio directly into the modulator. Most amateur FM transmitter sections use a varactor diode to modulate the carrier. This varactor converts voltage changes on the input to frequency changes on the output. Since rarely will the input audio not have a DC offset, it is necessary to use a capacitor to couple the 9600 bps audio to the varactor. This will prevent a shift in the base frequency. Normally a 20pf or so capacitor is used to couple the audio to the varactor circuit.

=====

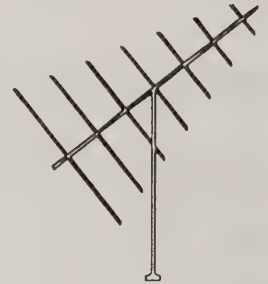
When operating any of the digital satellites there are two things to always remember:

- (1) Don't use excessive uplink power and
- (2) Listen before you transmit.

Considerations on Digital Satellite Station Equipment

Antennas

Dave Guimont
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Though this article is intended primarily as a comparison of the various antennas being used in operation of the MICROSAT Amateur Radio Satellites, some general comments may serve as a useful reminder. These comments apply to ALL antenna systems, but become increasingly important at the higher frequencies.

Use the best connectors and feedline (consistent with the frequency of operation) you can afford to buy. Install the connectors carefully, and keep the feedlines as short as possible. Mount the antennas only as high as necessary to clear obstructions in the immediate area. This not only allows shorter feedlines, but if you live in a metropolitan area it may shield you from being bombarded by proliferation of RF in those areas.

First a word about the transmit antenna. This discussion will concentrate on the receive system. Lack of gain in the antenna can obviously be made up with the transmit power used, but a word of caution here. Use no more power than necessary to access the satellite. Their receivers are very sensitive, and some experimenting will be necessary dependent on your system.

The choice of an antenna system depends largely on what you wish to accomplish, coupled with what you are willing to spend. If you want to copy every last bit from the satellite when it is in view, use directive antennas with automatic tracking. They work very well, but for frequent operations it is probably overkill. A simple ground plane vertical will do SOME copying, dependent on satellite elevation; it is suitable for only casual operating. The serious operator will want something better.

A turnstile antenna is a step above the ground plane. It is inexpensive, easily home-brewed, and does exhibit circularity at higher elevation angles. Performance at low elevations is quite poor. The obvious advantage, of course, it requires neither rotors or a tracking system.

The Lindenblad has been constructed by a number of amateurs for satellite operation. It outperforms the turnstile, but somewhat more complicated to build and THE SATELLITE EXPERIMENTER'S MANUAL has instructions. The antenna is typically constructed with either right or left hand circularity and necessitates building two antennas to enable selection. The author posted instructions and photographs for building a selectable polarity antenna on the microsats. A pull on a nylon fishing line attached to one of the elements rotated the elements to the opposite polarity.

Considerable time and effort has been put into experimenting and comparison testing of the quadrifilar antenna. It is easy and inexpensive to construct, and outperforms the Lindenblad. Thruput increases at all elevation angles over the Lindenblad when mounted vertically fixed.

Beamwidth has been estimated at 140 degrees, empirically. Pictures and construction details have appeared on the Microsats. Dual antennas with a splitter in various configurations are described in the same article.

All quadrifilar experiments were completed using a two meter version fixed vertically. Some experiments were performed on Oscar 13 using the quadrifilars at ideal pointing angles and they performed well. They could very well be a viable antenna for Phase IIID with its increased gain. Buy all materials new, and the 435 Mhz version can be built for about \$10. The two meter version will cost about \$20, and materials for both are easily obtained.

Microsats are a lot of fun. If you now have satellite capability, you can add them to your operations with very little expense. This is not intended as a "how to" article. Hopefully, it will give you some insight and assist you in station assembly.

Antenna Polarization

Jim White

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The following is based on design data, direct measurements and experimentation, surveys, and anecdotal evidence from discussion threads on the digital birds and CompuServe. I believe the empirical data is correct, but an error or two could certainly have crept in. I submit it for discussion and comment.

The sense (right or left) of the circular polarization of the four original Microsats changes depending on the transmitter in use. There was no attempt to make a particular transmitter any sense. The way they came out was based on how the semi-rigid cable and components could be designed into the transmitter module.

Here is a list of the sense of each one:

AO-16 RC 437.050 RHCP
AO-16 PSK 437.025 LHCP
DO-17 xmtr A 145.825 LHCP
DO-17 xmtr B 145.825 RHCP
WO-18 RC 437.100 RHCP
WO-18 PSK 437.075
LO-19 RC (&CW) 437.125 RHCP
LO-19 PSK 437.050 LHCP

The AO-16 PSK xmtr and the WO-18 PSK xmtr have problems and are not presently in use (although the AO-16 PSK transmitter - with LHCP - was used for about three years). We normally run xmtr B on DOVE because it is slightly more efficient. Last time I checked LO-19 was being switched occasionally between it's two. So it is strictly coincidence that three of these are RHCP virtually all the time. LO-19 changes. Problems with any of the xmtrs presently in use could result in a switch, which would change their downlinks to LHCP.

As long as you are receiving strong signals from these satellites, miss-matched sense will not reduce the margin enough to cause missed data. However, if the signal is weak, because of a marginal receive arraignment or low power from the satellite, miss-matched sense will cause significant loss of data. Uplinks are not a problem because they use monopoles and the receivers are very sensitive.

FO-20 is circular and has a fixed sense both up and down, but because of it's orbit geometry and motion, continuously good signals through it for an entire pass can only maintained if sense is switched, usually several times and on both uplink and downlink. This is particularly noticeable in analog mode.

I'm not certain of the antennas in use on AO-21, but it is clear from a little experimentation and from listening to the DSP FM repeat mode, that changing sense makes a significant difference in the overall link. At times, it is the difference between being heard and not. It changes during a pass.

The UOSAT series use monopole antennas. I have never noticed a difference in link efficiency when sense is switched.

I have no data on which AO-26 transmitter has which sense. But this is a Microsat design, so changing transmitters will change sense. In it's first weeks of store and forward operation it was running very low power and incorrect sense made a large difference in received strength during most parts of most passes. If it continues to be necessary to run low power from this satellite, or if the LHCP transmitter is used, left hand sense will be necessary, and switching during a pass may be essential for efficient operation.

AO-27 (EYESAT) uses a monopole for the downlink so sense makes little difference when the amateur transmitter is on high power. However, when receiving very weak signals from it (exciter only), switching sense is necessary to be able to even detect the signal at times. It remains to be seen how much power this bird will be able to sustain on it's amateur (secondary) transmitter, so downlink sense could be an issue. Uplink is not an issue, as a monopole is used with very sensitive receivers.

UNAMSAT is built on a Microsat design. It's downlink sense may be left or right depending on which transmitter is used. Downlink power and sense will not be known until this bird is in orbit and becomes operational. During checkout it is likely both transmitters will be used at times, requiring sense switching. Tumbling during the first few days in orbit will almost certainly require switching. Downlink power **could** be somewhat lower than AO-16 and LO-19 because of the power necessary to run the meteor experiment transmitter. This situation would be similar to WO-18, which routinely runs at about half of the power of AO-16 and LO-19 because of the need to support the experiments.

VOXSAT will use monopole antennas, so the link polarization and sense needs may be similar to AO-21.

AO-13: Gain antennas are RHCP. When the satellite is at or near apogee and/or pointing angles are good, RHCP is always best. However, when there is significant off pointing or the omni's are in use, LHCP can often result in better uplink and downlink signals. LHCP can be better both in terms of more strength and reduced depth of spin modulation fade.

Last I heard from Stan Woods, P3D will use all RHCP for its circular antennas. Since it will be nadir pointing at all times, sense switching should not be necessary. This assumes all goes as planned (and we certainly hope it does!)

I may have left out a bird or two, & have not hit all those being planned. Nor have I attempted to exhaustively document all situations or those of interest only to command stations. However, there are numerous situations in the foregoing where LHCP is necessary or favored. Using the wrong sense will reduce efficiency and/or enjoyment. In a few cases it may make operation impossible. There is certainly much enjoyment available to a satellite enthusiast with fixed RHCP antennas (or even linear). But I hope I have shown that full utilization of our satellite resources requires switchable curricular.

Preamplifiers

Dale Henkes, AB4NJ

When is it beneficial to use a preamp to enhance receiver performance and when is it not and why? These are questions that are sometimes confusing to the HF operator who is contemplating moving into the VHF and higher frequencies. It is generally understood that a preamp should increase the sensitivity of the receiver. But why is it recommended equipment for frequencies at VHF and above and not below?

The answer to these questions lies in the subject of noise. The sensitivity of a receiver (i.e its ability to detect weak signals) is limited by its internally generated noise. Signals weaker than the noise level of the receiver are masked by the noise and are not heard.

At this point it is important to eliminate one common misconception. Gain should NOT be equated with sensitivity. In the days when Edwin Howard Armstrong invented the regenerative circuit, the gain that resulted did improve the sensitivity of receiving apparatus of the day- by many thousands, even tens of thousands of times! However, the state of the art in receiver design was soon reached where simply increasing the gain did not result in a corresponding increase in sensitivity. Noise, especially atmospheric noise, became a limiting factor.

At HF, atmospheric and man-made noise is so strong that adding a preamp does not usually improve the situation. It amplifies the noise along with the signal with little improvement in signal to noise ratio. A better antenna that acquires more signal does much more to improve sensitivity than will the addition of a preamp. Unfortunately, at HF, it is difficult because of size restrictions to build antennas with gains much over 10 db.

The situation is vastly different at frequencies approaching VHF where the noise in the

atmosphere begins to drop off steadily as the frequency is increased. Here we have a double benefit. Not only is there less noise, but wavelengths are shorter permitting construction of higher performance antennas that are relatively small in size. Now single Yagi antennas can be built that have greater than 14 db and 17 db gain at 2 meters and 70 cm respectively. And these can be stacked to produce gains well in excess of 20 db.

At higher frequencies there comes a point where the noise in the atmosphere drops below the noise level of the particular receiver used. When this happens, sensitivity is directly related to the total noise figure of the receiving system. Therefore, any improvements that can be made in the overall noise figure result in the improved capability of the receiver to detect and amplify weaker signals. The increase in sensitivity results in clearer not just louder signals.

So we just have to make or buy a very quiet receiver, right? Wrong! Even if we had an impossibly quiet receiver with a noise figure of 0 db we would need to connect it to the antenna through a piece of coax or some sort of transmission line. The facts are that the loss in the transmission line add directly to the noise figure. At 70 cm, some of the best coaxial cable apart from hard line has approximately 3 db loss in 100 feet. We have just turned our impossibly quiet receiver into a rather unimpressive 3 db noise figure receiving system.

Now here is where the preamp comes in. Adding a preamp at the antenna end of the coax starts us out with a noise figure approximately equal to the that of the preamp. There are preamps available on the amateur market with noise figures less than .4 db. More common, however, are those that are less than 1 db and these are still quite adequate for most satellite work. What about the coax? Does it still add 3 db of noise to the system? The answer is surprisingly no. The gain of the preamp, placed ahead of the coax, tends to overcome the losses and reduces the effect of the losses on the total noise figure according to the following formula.

$$F_t = F_1 + (F_2 - 1)/G_1$$

Where F_t is the total noise factor expressed as a ratio(not in db).

F_1 is the noise factor of the preamp.

F_2 is the combined noise factor of the coax plus receiver.

G_1 is the gain of the preamp expressed as a ratio.

Example 1: Suppose we have the ideal receiver above with $NF = 0$ db (noise figure), 3 db of coax loss and a typical preamp with .7 db NF and 20 db gain. Lets plug in the numbers and see what happens.

20 db is a ratio of 100/1, so $G_1 = 100$. 3 db is a ratio of 2/1 so $F_2 = 2$. 0.7 db is a ratio of 1.175/1 so $F_1 = 1.175$. Therefore,

$F_t = 1.175 + (2 - 1)/100 = 1.185$, or converting to db:

$F_t(\text{db}) = 10 \text{ Log}(1.185) = 0.737$ db.

Notice that the coax added less than 0.04 db to the overall noise figure.

Now, lets get real and use a practical receiver with a real NF instead of the 0 db used in the example above. Suppose our real receiver has a noise figure of 1.5 db. That is more than twice the NF of the preamp.

Example 2: We will rework example 1 with a receiver NF of 1.5 db or a ratio of 1.41/1. Now $F_2 = 1.41 + 2 = 3.41$.

$$F_t = 1.175 + (3.41 - 1)/100 = 1.2$$

$$F_t (\text{db}) = 10 \text{ Log}(1.2) = 0.79 \text{ db.}$$

Notice that the coax plus receiver added less than 1/10 th of a db to the total noise figure. In both examples the total noise figure is approximately that of the preamp NF. This is what is meant by the statement that the total noise of the system is set by the preamp.

Now lets investigate the result of putting the preamp at the receiver end of the coax. Now F_1 is the combined NF of the preamp and coax or 3.7 db. Expressed as ratios for the formula, $F_1 = 2.344$, $F_2 = 1.41$ (for 1.5 db receiver) and

$$F_t = 2.344 + (1.41 - 1)/100 = 2.35$$

$$F_t (\text{db}) = 10 \text{ Log}(2.35) = 3.71 \text{ db.}$$

If no preamp was used at all, the noise figure in this example would have been 4.5 db. So placement of the preamp at the receiver end of the coax results in only marginal improvement.

A noise figure of nearly 4 db is disastrous for weak signal work and illustrates why the preamp should always be located at the antenna end of the coax. Satisfactory performance with the preamp in the shack can only be achieved if very low loss transmission line is used.

Transmission line

Mike Crisler, N4IFD



Whichever route you choose, please pay particular attention to the transmission lines. At VHF/UHF frequencies the loss associated with feedlines becomes very important. For example, at 437 mhz a 100 foot length of RG-58 coax exhibits a loss of more than 5 dB. What this means is that between the time the signal leaves your antenna and arrives at the receiver, it has lost more than two thirds of its signal strength. On a marginal system, this can mean that the signal will not appear much above the noise- or more than likely not appear at all. For short runs (under 25 feet), RG-8/RG213 may be adequate. Much over that distance, I strongly recommend a low loss cable such as Belden 9913. Over 100 feet, you should really consider hardline for your 70 centimeter antenna and perhaps 9913 for 2 meters.

Additionally pay particular attention to your connector terminations. UHF (PL-259s) type connectors may be okay at 2 meters, but at 70 centimeters, only "N" type connectors should be used. Most N-type connectors available at swap meets will not fit on 9913. There is an Amphenol connector (#82-202-1006) with a large center pin made for 9913. It is available along

with Belden 9913 from Nema Electronics, Inc., 12240 N.E. 14th Ave., North Miami, Florida 33161, (305) 893-3924. Certified Communications (see their add in QST) also has these connectors.

I would encourage you to use type-N fittings on your coaxial cable whenever possible. These connectors have very low loss and are very reliable. If you end up with a piece of gear with the standard SO239 or PL259, consider changing these to type N connectors, they perform much better for satellite usage. In some cases you can specify the type of connector when ordering gear. If you can, specify N.

Due to the construction of the N-type connector, the coax is held in place mechanically by the shield, rather than being soldered to the connector body as with the PL-259. Since 9913 has a foil shield with only a small amount of braid, the connector can support only a small amount of stress. I would strongly suggest some form of "stress relief" to prevent the weight of the cable from being supported by the connector (as at the drop from the bottom of your antenna). Heavy duty heat shrink tubing, overlapping both the connector and the cable by several inches, is one effective method of accomplishing this. In any case, 9913 is worth the effort.

Please pay close attention to weather-proofing your connectors and feedline system. Moisture intrusion into coax and associated connectors will quickly degrade the performance of your carefully planned system. I use heat-shrink tubing or good electrical tape sprayed with clear Krylon over my fittings. Also, the type-N connectors greatly reduces the possibility of water intrusion. Some hams use silicon type RTV sealant to assist in the waterproofing of their stuff. **USE CAUTION HERE!** If the "right" kind of silicone/RTV ISN'T used, more damage can be done in the long run than good. You must use a non-corrosive silicone/RTV. Most silicone and RTV sealants have acetic acid in them. That's why they smell like vinegar when uncured (wet). Do you intentionally want to use acid on your connectors and sensitive electronic gear? I don't! The run-of-the-mill stuff you get at your local hardware store IS going to be the corrosive type. Sniff it next time and note the vinegar like smell (no you won't get busted for sniffing this type of "glue").

The non-corrosive type is the only type which should be used. Dow Corning 3145 RTV adhesive/sealant IS a non-corrosive type and the only one I use on my electronic stuff. (I don't own Dow stock. I just don't know who else makes non-corrosive RTV.) It is worth the extra effort to find this stuff.

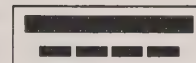
Take your time and assemble these N-type connectors "perfectly", accept nothing less. The ARRL handbook has excellent instructions on how to assemble these connectors. Most experienced UHF/VHF operators will attest to the importance of this step. Nothing is more aggravating than to find after a hard rain that the "N" connector on your 70 centimeter vertical mounted at 60 feet on the tower has managed to fill with water. Wrap the connection with a good grade of electrical tape as a minimum. Seal it with a spray sealer such as Clear Krylon. Let it dry and repeat the process. Once that's done, coat the entire surface with a coat of silicone/RTV. Another option is to use one of the high grades of thick walled heat shrink tubing to weatherproof and strengthen these connections.

Receiver/Transmitter/Downconverters

Generally any of the receivers or transmitters from the major manufacturers can be used reliably. Units with UP/DOWN buttons on the microphone and with serial interfaces are especially helpful. Make sure that the radio tunes 435-437 MHz SSB and FM. 430 MHz downconverters work very well as far as converting the signal. You may find that some problems arise in not having the UP/DOWN buttons on the HF receiver and in not having the fine tuning control needed for the digital satellites. Looking at the list of receivers and transmitters in Appendix E, most of the common VHF/UHF equipment is represented.

DSP Units

DSP (Digital Signal Processor) based communication units are a combination hardware/software signal processing unit. The hardware converts the analog audio signal into a digital signal and the software performs mathematical operations upon it. The DSP data units talk serially to a computer, so any computer will work. The advantages of this system are the great flexibility and a resistance to obsolescence because new modems can be implemented by writing a new piece of software. The 1200 bps AFSK, the 1200 bps PSK and the 9600 bps AFSK modems and TNC can all be replaced by this one device. The apparent disadvantage of these devices is the cost. But, if you were to calculate the cost of the hardware necessary to duplicate all of the included communication modes, you would see that the price is quite in line. Not to mention the fact that a infinite number of modes are just a software addition away. Add to this the fact that no new cabling is required and there is a consistent interface to the computer. Figure XX and XX show the Main Menu screens of the L.L. Grace and AEA DSP units. For more information on DSP see the article, 'DSP and the Average Satellite Operator', AMSAT Journal Nov/Dec 92 or the Proceedings of the AMSAT Tenth Space Symposium, 1992.



DSP-12

The DSP-12 offers a flexible platform for digital communication modes and terminal interfaces. Figure 3 shows the main menu selection with the currently available modes. New modes become available every few months. Upgrades can be run from internal RAM or by simply changing three EEPROMs. Three ports labeled HF, VHF & UHF can be individually selected for transmit and receive. The unit has an open architecture and encourages customers to develop new modems or terminal interfaces. A Developer's Toolkit is offered with schematics and source code for the V40 microprocessor. The DSP chip used is the Motorola 56001. A Debugger is included to assist the user in developing applications. CompuServe and the DIRG BBS are used to exchange ideas, to pose questions, to post new applications and to get upgrades. Users can switch from one application to another without going through the main menu.

Figure 3 L.L. Grace DSP-12 main menu screen

```
*****
*                               Main Menu                               07/29/92 00:02:00 *
***** GCE Version 1.99 *****
<A> HF      Packet      <U> 75  BPSK Packet      <H> RTTY: Baudot
<B> VHF      Packet      <Y> 100 BPSK Packet      <I> RTTY: ASCII
<E> FO-20    Packet      <X> 150 BPSK Packet      <J> RTTY: Extra RTTY 1
<P> PACSAT   Packet      <T> 300 BPSK Packet      <K> RTTY: Extra RTTY 2
<F> UO-22    Packet      <S> 600 BPSK Packet      <L> RTTY: Extra RTTY 3
<N> HAPN     Packet      <D> 1200 BPSK Packet     <W> NOAA APT*
<G> AO-13    Telemetry   <Z> Audio Sample/Play/Pipe <V> ACARS
<R> UO-11    Telemetry*  <M> AMTOR*      <9> Setup

Enter your selection...f
** UO-22 PKT Mode **

** Use $03 (^C) to enter Command mode **

** Use the Display command to see all parameter settings **

<UO-22 PKT> cmd:
* * * * *
```

DSP-1232/2232

The DSP-1232 and -2232 are two models of this multi-mode DSP data controller. Both models have two ports, the 2232 can run two ports simultaneously. Figure 4 shows the main menu of the DSP-2232, illustrating the multitude of available modes. Upgrades are made by simply replacing a factory EPROM or downloading a file from the BBS and burning your own. The Motorola 56001 DSP is used together with a Zilog HD64180 microprocessor. Much of the protocol conversion is done in hardware. The 2232 model has a two line LCD display to provide status information to the user. CompuServe has an AEA forum for user's to pose questions and exchange ideas. The p1 and p2 in Figure xx refer to port 1 and port 2.

Figure 4. AEA DSP-2232 main menu screen

```
(920723)
. 1: RTTY/TOR 170: 2125/2295      2: RTTY/TOR 170: 1445/1275
. 3: RTTY/TOR 425: 2125/2550      4: RTTY/TOR 850: 2125/2975
. 10: p1 Packet 300 bps HF 2110/2310 11: p1 Packet 300 bps HF 1460/1260
. 12: p1 Packet 1200 bps VHF          13: p1 Packet 1200 bps PACSAT
. 14: p1 Packet 1200 bps PSK          15: p1 Packet 2400 bps V.26B
. 16: p1 Packet 4800 bps PACSAT       17: p1 Packet 4800 bps PSK
. 18: p1 Packet 9600 bps FSK K9NG/G3RUH 20: p2 Packet 300 bps HF 2110/2310
. 22: p2 Packet 1200 bps VHF          23: p2 Packet 1200 bps PACSAT
. 25: p2 Packet 2400 bps V.26B        28: p2 Packet 9600 bps FSK K9NG/G3RUH
. 30: RTTY/TOR 170: 2125/2295; p2 Packet 300 bps HF 2110/2310
. 31: RTTY/TOR 170: 2125/2295; p2 Packet 1200 bps VHF
. 33: p1 Packet 300 bps HF 2110/2310; p2 Packet 1200 bps VHF
. 35: p1 Packet 1200 bps VHF; p2 Packet 1200 bps VHF
. 40: Morse 750 Hz                  41: Analog FAX HF
. 42: Analog FAX APT                43: Analog SSTV
. 44: DSP data 400 bps OSCAR-13      45: RTTY/TOR 1200 bps ASCII OSCAR-11
. 46: DSP data Spectrum              50: p1 Packet 1200 bps MSK
. 51: p1 Packet 2400 bps MSK          52: p1 Packet 9600 bps G3RUH UO22 eq
. 60: p2 Packet 1200 bps MSK          61: p2 Packet 2400 bps MSK
```

L.L. Grace Communications Products, Inc.
P.O. Box 1345
Voorhees, New Jersey 08043
USA
Tel (609) 751-1018
FAX (609) 751-9705
(Kansas City Tracker/Tuner)
(DSP-12 Multi-mode controller)

Advanced Electronic Applications, Inc.
P.O.Box C2160/2006
196th Street S.W.
Lynnwood, Washington 98036-0918
USA
Tel (206) 774-5554
(DSP-2232, DSP-1232 multi-mode controller)

DIGITAL SATELLITE MODEMS

A modem is a device that MODulates/DEModulates serial data. The terrestrial TNC you have includes a modem that works on 1200 bps AFSK encoded data. For the satellites in Digital Group A you need only this off the shelf device. But as the bit rate and modulation type change a new modem is needed. One for each bit rate and modulation type change. The satellites in Digital Group B and C require 1200 bps PSK modems to decode and encode the data. These modems go between the receiver/transmitter and the TNC. They actually replace the FSK modem function of the terrestrial TNC by performing the PSK demodulating/modulating functions. The data is still acted upon by the TNC. Satellites in Digital Group D require a 9600 bps AFSK modem. The strong signal, the high data rates and the large number of satellites using this format, make this the most popular group of the six. The satellites in Digital Groups E and F need specialized modems mainly for telemetry and bulletins. These are covered fully in the AMSAT publication, 'Decoding Telemetry from the Amateur Satellites', and will not be explored further here.

1200 bps Modem to Transceiver connections

The 1200 bps modem to transceiver connection can be made to the microphone connector. For PSK operation it is nearly mandatory to have a radio that has up/down frequency buttons on the microphone. The PTT line is also needed by the MODEM/TNC. If your mic connector has speaker audio also, so much the better.

The audio connections to these modems are a simple connection to the microphone and speaker. Slight adjustments to the audio level at the modem will be necessary, but this is not a difficult matter. The audio going into the radio should be the same level as that from the microphone. The variable speaker out, the fixed speaker out or the line out audio is used as input to the modem.

The rapid doppler shift of the 1200 bps digital birds makes it nearly essential to have the MODEM control the receive frequency of the radio. This is accomplished by a PLL (phase lock loop) inside the modem. This circuit samples the audio and keeps the carrier centered by adjusting the receive frequency via the up/down microphone buttons. It is a constant task to do this manually, and any lapse will cause the modem to loose carrier lock, digital data and keep losing data until the signal carrier is locked again. The wide FM signal of the 9600 bps satellites doesn't offer as much of a problem. If your receiver has a discriminator meter, it is simply a matter of keeping the signal centered.

1200 bps PSK MODEMS

For the 1200 baud PACSATs (AO-16, WO-18 or LU-19) and FO-20 there are essentially two units. One is a PSK modem kit available from TAPR or a fully built unit from PacComm. The G3RUH JAS-1 PSK modem PCBs are now difficult to find, but function very well. Don't hesitate to get one, if you run across it. PacComm offers two units, a fully built unit to interface with a TNC and a unit attached to a TNC.

TAPR 1200 bps PSK modem kit
PacComm PSK-1 or PSK-1T(This includes a TNC)

TAPR (Tuscon Amateur Packet Radio)
8987-309 E. Tanque Verde Rd. #337
Tucson, AZ 85749-9399
phone (817) 383-0000
fax (817) 566-2544
Tuesday - Friday, 9:00-11:00am, 3:00-5:00 CST

PacComm Packet Radio Systems
4413 N. Hesperides St.
Tampa, FL 33614-7618
phone (813) 874-2980
fax (813) 872-8696

9600 bps AFSK MODEMS

Looking at the list of 9600 bps MODEMS employed by the UO-22 users in Appendix E that the G3RUH 9600 bps modem is the standard. Most companies have licensed the 9600 bps circuit from James Miller, G3RUH. James has long contributed his talents to the satellite community by providing the 9600 bps AFSK modem, the 1200 bps PSK modem and two 400 bps modems to the satellite world at a modest cost. In addition James authors countless articles on satellite topics and in his spare time is one of the three control stations for AO-13. James is a classic example of a tireless AMSAT volunteer, that quietly keep amateur satellites available to all of us.

The 9600 bps modems connect to the TNC in the same way as the 1200 bps PSK modems, via the modem disconnect header. **BUT** the modem to radio(s) connections are quite different. The wide bandwidth required of the 9600 bps data makes it necessary to bypass the narrow filters, designed to pass voice signals, in the receive and transmit circuits.

available 9600 bps modems:	TAPR 9600 modem
	PacComm MC-NB96 internal
	PacComm EM-NB96 external
	Kantronics DE9600
	MFJ MFJ-9600
	DRSI DPK-9600

TNCs

The most common TNC (Terminal Node Controller) used for terrestrial BBS operation is a combination MODEM (MODulator/DEMODulator) and a PAD (Packet Assembler/Disassembler) for AX.25 protocol. There are numerous versions of TNCs with one modem, without modems or with multiple modems. For simplicity I will refer to a standard TNC as having a 1200 bps MODEM and an AX.25 PAD. Most of the 1200 bps TNCs available today are based upon the TAPR (Tucson Amateur Packet Radio) TNC-2 design. These have a BELL-202 compatible modem and operate on AX.25 protocol. Most of the TNCs also use a command set similar to that of the TAPR TNC-2. There are additional commands included with other TNCs and new commands introduced with each software revision. So I will be speaking specifically about the TNC-2 commands, but these commands should be the same or have a counterpart in other brands of TNCs.

Terrestrial TNCs are used in half duplex mode. This means that only one station transmits at a time. The second station waits until the first station stops transmitting before the second station transmits. Normally both use the same frequency. The satellites in Digital Group A also use half duplex mode. So the same TNC that you use for your terrestrial operation can be used for the satellites in Group A. In Appendix E is a list of TNCs used by stations for 9600 bps digital communication with UO-22. You can see that the majority of common TNCs are represented in the list. So nearly any TNC you have or get can be used with the digital satellites.

These features need to be present in a TNC for operation with the various digital groups:

- 1) A 19,200 terminal port is best, a 9600 port is necessary for the satellites in Digital Group D.
- 2) TAPR Software Revision 1.1.7 or above, so that the correct KISS implementation for satellites in Digital Group C and D.
- 3) A modem disconnect header, to allow other modems (PSK or 9600) to interface to the TNC.
[TAPR offers a kit for the PK232, and an installation kit for the PK232MBX]

The strong, constant signal sources you are used to from the local terrestrial BBS probably has not caused you much concern. You can read the DIR, read messages, upload and download files without much problem. I suggest that you get out your TNC manual and check out some of the error checking commands that the device provides. I think you might be surprised at the number of packets that your TNC does not decode correctly. These may be from stations that are at your fringe area or behind some obstacle. Your ear can hear them, but your TNC can not demodulate exactly. Table 6 lists some of the error checking commands available with TNC-2 version 1.1.7b. Improvements made in the reception of local signals that decrease the error counts will prove invaluable in your future digital satellite work. One of the key elements of digital communications is the reliability of the data. With the TNC, if the data checksum doesn't check out you don't get the data.

In April 1994 the current Rev of TNC-2 software is 1.1.8a.

TABLE 6. TAPR TNC-2 V1.1.7b software error count commands - Health

ASYFRERR	count of Asynchronous Framing Receive Error, serial port
ASYRXOVR	count of Asynchronous Receive Overrun, serial data not serviced in time at UART
ASYQOVR	count of Asynchronous Queue Overrun, serial data input buffer overrun
BBFAILED	number of bbRAM checksum errors
DIGISENT	number of frames digipeated
HOVRERR	HDLC receiver data not serviced fast enough
HUNDRERR	HDLC transmitter in not serviced fast enough
RCVDFRMR	count increased for each Received Frame Reject from the connected station
RCVDIFRA	count increased for each Received I Frame from the connected station
RCVDREJ	count increased for each Received REJect frame from the connected station
RCVDRNR	count increased for each Received RNR frame for this TNC
RCVDSABM	count increased for each Received SABM frame addressed to this TNC
RXABORT	count increased for each aborted frame received from the HDLC controller
RXCOUNT	count increased for each frame with good CRC (all frames if PASSALL ON)
RXERRORS	count increased for bad frame, i.e. too short, bad CRC, too long or noisy
RXLENERR	count increased for each Received frame with a length error
RXRESYNC	count increased for each Recovery of RXLENERR
SENTFRMR	count increased for each Frame REJect frame transmitted
SENTREJ	count increased for each I Frame transmitted
SENTRNR	count increased for each RNR frame transmitted
TXCOUNT	count increased for each correctly transmitted frame
TXQOVFLW	number of times frames were discarded because outgoing buffer full
TXTMO	number of times the TNC successfully recovers from HDLC XMT timeouts

Use the TAPR TNC command **DISPLAY HEALTH** or **DISP H** to list the above functions. You can set the commands to 0 by typing the name and a 0, or you can create an ASCII file with all of the commands zeroed and upload it to the TNC.

Terrestrial packet signals offer constant signal levels, but with satellite reception, the signal level constantly changes. The TNC is not as forgiving as the human ear, so when the satellite is close to the horizon and at high elevations you will notice data loss if you are using fixed antenna. Many nights I have heard MIR, SAREX or DOVE fine, but get no output on the computer screen. Two very important TNC commands are PASSALL and TRACE. These commands allow you to see the serial characters received by the TNC whether they pass the checksum or not. PASSALL ON allows the TNC to pass data packets heard but with an incorrect checksum. In the example below in FIGURE XX, the data was taken very early in the pass, just as it comes over the horizon. Without PASSALL ON no data would be displayed on the screen, until the 'LUSAT-11>PBLIST:PB: VE3FRH\WB9ANQ\D' line. This is an excellent tool when you are first getting started with the digital satellites to assure yourself that you are actually getting PSK or 9600 bps data. No data may show on the screen while you hear a 'good' signal. Simply type CTRL/C to get the CMD prompt, then type PASSALL ON. Now you will start seeing the data that the modem and TNC see, but the data checksum is invalid. You know you are receiving data, so you must optimize your received signal strength. This can be done with a pointable antenna and/or a preamp.

Figure 5. TAPR TNC2 V1.1.7b PASSALL ON sample display

```
LUSA-11>RBLI3T:PB:<empt{.

LUW-9>TIM-3:PHT: uptime is 923/23:5<~24629+22a8::
>RS,,,,,,,,, :SqT,NL=:@@bf3-_sYVU*~a@%uiL
LUSAT-11>TBLIST:PB: WB9ANQ\D WE3FRF]D

>-9,,,,,,,,, : (x64-x64
LUSAT-1>TLO:4-juiovl
X3P19%

$Z }!m"#6$0%*&'() *+,-7./&0%1&23[4,506G7-8C9,,:,<
LUSAT-11>QST-1: p:Yx4-" }4-*Up:BL940419      `C&3-Zx4-Yx4-J)b

Ph;
LUSAT-11>PBLIST:PB: VE3FRH\D WB9ANQ\D

LUSAT-1>LSTAT:I P:0x14CA o:0 l:1389 f:1507, d:1 st:5

LUSAT-12>BBSTAT:Open ABCD:
LUSAT-11>QST-1: o:v4-Xx4-*Uo:AL940419      2K 3-v4-v4-I3O
...
```

The TRACE ON command shows the hexadecimal values of the data received, the shifted ASCII address data and straight ASCII data. This command is especially useful in determining what the callsign of a satellite that is too weak or noisy to decode correctly. If the data is decoded correctly, then the decoded data is displayed after the numbered lines. In FIGURE XX these are the last two lines, the packet data.

FIGURE 6. TAPR TNC2 V1.1.7b TRACE ON command screen output

```
000: AE8268A6 B09AE096 A8688C40 406126F0 WA4SXMPKT4F 0.x ..h.....h.@a&.
010: 4D534720 23205452 20205349 5A452054 &)#...*)..)$-".* MSG # TR SIZE T
020: 4F202020 20204652 4F4D2020 20404242 '.....#)'&... !! O FROM @BB
030: 53202020 44415445 20202020 5449544C )..." *"...*$*& S DATE TITL
040: 450D3237 35343720 42232020 32333132 ".....!..... E.27547 B# 2312
050: 204B4550 4C455220 46423152 43492041 .%("(&").#!.)!$. KEPLER FB1RCI A
060: 4D534154 20203933 31303033 204D4952 &) *.....&$) MSAT 931003 MIR
070: 20416D73 61742064 61793D32 34340D . 690:.20<..... Amsat day=244.
MSG # TR SIZE TO FROM @BBS DATE TITLE
27547 B# 2312 KEPLER FB1RCI AMSAT 931003 MIR Amsat day=244
```

It is important to start investigating how your TNC works, because you will not have the same throughput as you do terrestrially unless you have an optimum setup. When you start trying to improve your data rate it is necessary to understand how your TNC works so that you can make it work for you with the most efficiency. This means you need to get that TNC manual off the shelf, where you stored it months ago, and start to learn about its operation and features. You will have to alter some of the parameters for the different satellites depending upon you station configuration. The best book on packet radio that I have seen is "Your Gateway to Packet Radio" by Stan Horzepa, WA1LOU. This book explains the development of packet radio, the theory and the operation in clear, easy to understand language. There is an excellent glossary and even a section on fine tuning your packet system. The book is an ARRL publication and is available from the ARRL, ARRL resellers and the RSGB. TAPR also sells a TNC-2 command booklet and a bare TNC-2 board, schematic and firmware for those wishing to build their own TNC-2.

Interfacing Modems to the TNC

The satellites in Digital Groups B, C and D use a different MODEM, either a 1200 bps PSK MODEM or a 9600 bps FSK MODEM. These MODEMs are interfaced to the TNC via the modem disconnect header. Often this is a 20 pin header. This connector has a shielded cable attached that passes the demodulated signal to the TNC and takes the data to be modulated to the external MODEM unit. In other words, the 1200 bps FSK modem in your TNC is bypassed. The AX.25 operations of the TNC are still used for the satellites in Digital Group B. Invoking KISS mode in your TNC allows only minimal protocol operation of the TNC by the satellites in Digital Group C and D. The raw data and protocol are operated on by the programs PB/PG running in the computer.

TNC modifications

TAPR offers two kits that most TNC users will find helpful in improving data throughput. These allow DCD (Data Carrier Detect) operation with the squelch open. This modification will reduce the other stations' TXDELAY time.

The STATE MACHINE UPGRADE is for TNCs with modems such as: KPC-1, PacComm Tiny-2/Micro-2, KPC-4, DRSI PC*PA Type 1, KPC-2400, DRSI PC*PA Type 2, KAM, AIWA APX-25, AEA PK-88, TASCOT TNC-20, AEA PK-232, TASCOT TNC-20H, PacComm TNC-220, Heath HK-232 and Heath PocketPacket.

The XR-2211 DCD UPGRADE is for TNCs using the XR-2211 demodulator such as: TAPR Beta Board, GLB PK-1, TNC-1, GLB TNC-2A, TNC-2, PacComm TNC-200, Heath HD-4040, MFJ 1270, AEA PK-1, MFJ 1274, AEA PK-80, DRSI HF*MODEM.

Serial Communications

Connecting the modem to the computer should be a simple thing in this case, as the devices that you are connecting serially are the devices that the RS-232C standard were written for. It specifies the connection between a terminal (DTE, Data Terminal Equipment) to a modem (DCE, Data Communications Equipment). The cable should be 1:1 (pin 1 to pin 1, pin 2 to pin 2, ..., pin 25 to pin 25). To be safe and the most flexible you should use a cable that contains all 25 lines. For short distances a ribbon cable will work fine, you can even pick up the cable and press on D-shell connector at your local RS store. If your computer or modem uses a 9-pin D-shell connector or you have to connect the devices using a nine and a twenty-five pin connector, the same rule applies, use a 1:1 cable. The most important pins to connect are the ones contained in the 9-pin D-shell. Here is the mapping of a 9-pin to 25-pin connector to assist you in making a cable if you cannot find one. **REMEMBER** you want to use a straight modem cable between the modem and the computer.



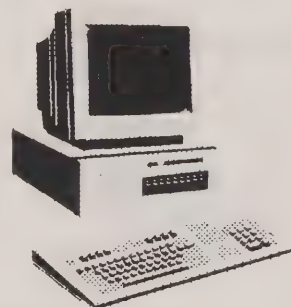
The section in the Appendix by 'RIP' Riportella on 'Notes on Bits and Bauds and the "PB" Program' does an excellent job of describing the correct way to discuss serial digital signals and

the associated downloading benchmark values displayed in the PB program .

DB-9	DB-25	
1	8	DCD (Data Carrier Detect)
2	3	RX (Receive Data)
3	2	TX (Transmit Data)
4	20	DTR (Data Terminal Ready)
5	7	GND (Ground)
6	6	DSR (Data Set Ready)
7	4	RTS (Ready To Send)
8	5	CTS (Clear To Send)
9	22	RI (Ring Indicator)

COMPUTER

The heart of your digital satellite system will be a computer. Most of the software was developed for the Intel processor computers, 80286, 80386 or 80486 with a minimum speed of 8 Mhz, 640K of RAM memory and greater than 80 Mb hard drive. DOS version >3.0 will work, but later versions are better. You may use DR-DOS with some limitations and it is not recommended. The only operational software available for non IBM compatible machines is called "PE1CHL-NET" which is available in versions for Atari, Unix and MSDOS. This software is uploaded to the satellite from time to time or may be obtained from a regular user. (NOTE for G4WFQ - PE1CHL advises that he does not distribute this software). PE1CHL-NET has its own documentation and is not covered by this manual.



Digital Satellite Station Software

Finding the Digital Satellites - Tracking Software

There are quite a number of programs available for tracking satellites. Many are available as freeware or as shareware on various BBSs. I have tried many of these. My advice is to get one of the tracking programs that AMSAT offers: InstantTrack v1.0b by Franklin Antonio, N6NKF and QuikTrak v4.0 by Bob McGwier, N4HY. Not only will these very well done pieces of software, but these programs were generously donated to AMSAT help raise funds for the satellites you are using. The heart of these tracking programs are the Keplerian elements (keps). These data values describe the orbit of the satellite. They are readily available in two formats: AMSAT format and NASA format. See Figure XX. All of the tracking programs from AMSAT allow automatic updating of the Keplerian elements, so no laborious data input is necessary. Most packet BBSs have a current set of Keplerian elements and land line BBSs also, such as:



Western pacific BBS	(415) 453-2854	up to 14.4 kbps V.32bis
ARRL BBS	(203) 666-0578	
AMSAT Sats & Stats BBS	(201) 261-2780	up to 14.4 kbps
HAMLINK	(612) 426-0000	up to 9600 bps
CompuServe HAMNET forum.		

Both formats contain the same data. The NASA format is more compact, the AMSAT format is for human consumption. Both formats are just as readable to the computer. In 1993 the group the group that puts out the NASA format kept changed the way the checksum on each line was computed. So the original version of INSTANTTRACK doesn't agree on the checksum. A fix is readily available on many BBSs or from AMSAT.

Figure XX. Sample Keplerian element sets

NASA format

```
AO-16
1 20439U 90005D 94076.19336562 .00000065 00000-0 42387-4 0 7743
2 20439 98.6002 163.3475 0012127 99.9777 260.2776 14.29885704216451
DO-17
1 20440U 90005E 94076.22662674 .00000074 00000-0 45623-4 0 7730
2 20440 98.6015 163.6736 0012240 99.1450 261.1119 14.30024568216474
```

ANSAT format

```
Satellite: STS-59
Catalog number: 23042
Epoch time: 94102.60601196 (12 APR 94 14:32:39.43 UTC)
Element set: GSFC-014
Inclination: 56.9943 deg
RA of node: 248.7421 deg Space Shuttle Flight STS-59
Eccentricity: 0.0009326 Keplerian Elements
Arg of perigee: 283.3969 deg
Mean anomaly: 76.6081 deg
Mean motion: 16.21184650 rev/day Semi-major Axis: 6594.4697 Km
Decay rate: 0.20E-03 rev/day*2 Apogee Alt: 222.23 Km
Epoch rev: 52 Perigee Alt: 209.93 Km
```

Since the useable window for the digital satellites is small, it is important to be able to reliably know when the satellite is going to be visible. Two things must be updated regularly to be able to track the LEO satellites reliably.

- (1) Make sure that your computer clock is correct;
- (2) make sure that your keplerian elements are over three weeks old.

Both InstantTrack and QuikTrak provide the software to automatically make a modem connection to NBS in Colorado and then update your computer clock. The EPOCH describes the time that the Keplerian elements were taken. The first digits are the YEAR, the next three are the day in that year (00 to 365). The decimal values are what part of the day. INSTANTTRACK has a nice feature to tell you instantly how old the elements are. Simply press the 'D' key when in the elements edit mode. See Figure XX. Note that this element set is old. (Easiest entry is while in the REALTIME GRAPHIC display, type "E" for edit, then "D", for derived values.)

Figure 7. INSTANTTRACK display for Manual Edit of the Elements

```

Manual Edit Satellite Elements
Database Entry: 16
Satellite: AO-16
Object Number: 20439
NASA Designation: AO-16
Epoch Time, T0: 94 76.1933656
03/17/94 04:38:26.78 UTC
Epoch Rev, K0: 21645
Mean Anomaly, M0: 260.27760°
Mean Motion, N0: 14.29885704
Inclination, I0: 98.60020°
Eccentricity, E0: 0.00121270°
Arg Perigee, W0: 99.97770°
R.A.A.N., O0: 163.34750°
Beacon Frq, F1: 437.051
Decay, N1: 6.50000e-007
Schedule:
Attitude: None Set
Diameter: 0.0
Groups: ad

Derived Values...
(Adjusted to Present Time)

Epoch was 32.5 days ago.
Satellite age is 1546 days.
Orbital Period: 100.707 minutes
Perigee Height: 783.4 km
Apogee Height: 800.8 km

Lat. of Apogee: -4.6° +2.904°/day
Arg Perigee: 4.63732° -2.937°/day
R.A.A.N.: 195.45116° +0.989°/day

↑↓ to select element.  → to select satellite.  D to display derived values.
= to enter new value.  Q to return

```

=====

A very useful set of utilities for INSTANTTRACK are available from AMSAT. These were written and donated to AMSAT by Paul Williamson, KB5MU. One of the most useful ones in planning for passes is ITPASS. All the important information, satellite, time and maximum elevation for upcoming passes for one or many satellites. See Figures 8 - 11 for examples of batch files using this utility. The sample batch files are SKEDF.BAT, SKED.BAT and SKEDALLF.BAT. The examples show how to invoke the batch files and sample output information.

Figure 8. Sample Output from the ITPASS Utility, and batch file SKED.BAT

InstantTrack AOS/LOS Finder Version 0.81
 Copyright 1989-1993 Paul Williamson, KB5MU

Passes starting: 26 Dec 93 21:02:52 UTC

Satellite	AOS Time (UTC)	LOS Time (UTC)	Max El
ao-16	27 Dec 93 03:26:45	27 Dec 93 03:40:44	28°
ao-16	27 Dec 93 05:06:00	27 Dec 93 05:20:18	30°
ao-16	27 Dec 93 15:42:50	27 Dec 93 15:54:56	12°
ao-16	27 Dec 93 17:21:14	27 Dec 93 17:36:24	68°
ao-16	28 Dec 93 02:58:55	28 Dec 93 03:11:20	15°
ao-16	28 Dec 93 04:36:37	28 Dec 93 04:51:38	59°
ao-16	28 Dec 93 16:52:19	28 Dec 93 17:07:31	64°
ao-16	28 Dec 93 18:32:41	28 Dec 93 18:45:04	15°
ao-16	29 Dec 93 04:07:42	29 Dec 93 04:22:45	72°
ao-16	29 Dec 93 05:49:26	29 Dec 93 06:01:01	11°
ao-16	29 Dec 93 16:23:38	29 Dec 93 16:38:12	33°
ao-16	29 Dec 93 18:03:16	29 Dec 93 18:17:18	27°

Figure 9. Sample batch file to invoke ITPASS

```
c:> skedf ao-16
```

```
batch file SKEDF.BAT
```

```
rem list 20 passes of AO-16, greater than 10 degrees elevation to a file
```

```
itpass -n 20 -e 10 %1 >sked.dat
```

```
batch file SKED.BAT
```

```
rem list 20 passes of AO-16, greater than 10 degrees elevation to the screen
```

```
itpass -n 20 -e 10 %1
```

```
batch file SKEDALLF.BAT
```

```
rem list next 20 passes of AO-16 to a file
```

```
itpass -n 20 %1 >skedallf.dat
```

=====

A very useful output of ITPASS is a list of the next two passes with elevation greater than 10° for all of the digital satellites. Make sure that you have added a 'd' to the Groups field of each of the satellite elements you wish to include before this batch file will work. No parameters need be passed.

```
c:\>digisked
```

```
batch file DIGISKED.BAT
```

```
rem list all d group satellites for next 2 passes > 10 degrees
```

```
itpass -n 2 -e 10 -g d
```

See Figure 10. for a DIGISKED sample output.

Figure 10. Sample output of batch file, DIGISKED

ITPASS: InstantTrack AOS/LOS Finder Version 0.81
Copyright 1989-1993 Paul Williamson, KB5MU

Passes starting: 26 Dec 93 22:16:13 UTC

Satellite	AOS Time (UTC)	LOS Time (UTC)	Max El
=====	=====	=====	=====
ao-16	27 Dec 93 03:26:45	27 Dec 93 03:40:44	28°
ao-16	27 Dec 93 05:06:00	27 Dec 93 05:20:18	30°
do-17	27 Dec 93 02:47:20	27 Dec 93 02:58:44	11°
do-17	27 Dec 93 04:24:17	27 Dec 93 04:39:23	81°
wo-18	27 Dec 93 03:45:21	27 Dec 93 03:59:56	42°
wo-18	27 Dec 93 05:25:34	27 Dec 93 05:39:00	20°
lo-19	27 Dec 93 03:30:53	27 Dec 93 03:44:57	30°
lo-19	27 Dec 93 05:10:15	27 Dec 93 05:24:26	29°
fo-20	26 Dec 93 22:19:40	26 Dec 93 22:42:25	34°
fo-20	27 Dec 93 00:10:03	27 Dec 93 00:33:27	54°
ao-21	27 Dec 93 04:36:58	27 Dec 93 04:54:30	79°
ao-21	27 Dec 93 06:23:49	27 Dec 93 06:37:01	12°
uo-22	27 Dec 93 03:22:51	27 Dec 93 03:37:34	64°
uo-22	27 Dec 93 05:03:50	27 Dec 93 05:15:32	12°
ko-23	27 Dec 93 02:52:14	27 Dec 93 03:12:22	27°
ko-23	27 Dec 93 04:47:30	27 Dec 93 05:09:17	70°
KO-25	27 Dec 93 02:15:05	27 Dec 93 02:27:32	15°
KO-25	27 Dec 93 03:52:52	27 Dec 93 04:07:59	61°
IO-26	27 Dec 93 02:23:51	27 Dec 93 02:36:53	19°
IO-26	27 Dec 93 04:02:08	27 Dec 93 04:17:06	49°
=====	=====	=====	=====

The AMSAT tracking program QuikTrak also provides a list of future passes and maximum elevation. This can be done from the SCHEDULE function one satellite at a time or from the REALTIME MULTISAT tabular function for multi-satellites without the maximum elevation.

Figure 11. Sample output of QuikTrak scheduling functions

SCHEDULE FOR SATELLITE KO-25 FOR Knoxville							
DATE	AOS	MAX	LOS	EPOCH	DX/EL	AZ	ORBIT
27DEC93	021503	022113	022724	27DEC93	15 EL	64	1314
27DEC93	035248	040021	040753	27DEC93	61 EL	260	1315
27DEC93	053655	054048	054441	27DEC93	4 EL	273	1316
27DEC93	143245	143647	144048	27DEC93	4 EL	87	1321
27DEC93	160935	161712	162449	27DEC93	64 EL	96	1322
27DEC93	175010	175621	180232	27DEC93	15 EL	297	1323
28DEC93	014947	015448	015950	28DEC93	8 EL	58	1328
28DEC93	032555	033327	034059	28DEC93	74 EL	74	1329
28DEC93	050753	051337	051922	28DEC93	11 EL	270	1330
28DEC93	154300	155016	155731	28DEC93	34 EL	96	1336
28DEC93	172250	172948	173646	28DEC93	26 EL	292	1337
29DEC93	012525	012826	013127	29DEC93	2 EL	54	1342
29DEC93	025921	030640	031400	29DEC93	40 EL	70	1343
29DEC93	043944	044629	045314	29DEC93	21 EL	266	1344
29DEC93	151632	152313	152955	29DEC93	19 EL	94	1350
29DEC93	165532	170300	171029	29DEC93	46 EL	291	1351
29DEC93	183750	184126	184501	29DEC93	4 EL	305	1352

Figure 12. Typical QuikTrak REALTIME MULTISAT TABULAR screen

```

GMT/UTC is Thu Jun 27 04:02:06 1991      Local Time is Thu Jun 27 00:02:06 1991
Satellite      Az/El      Lng/Lat      Range/Ph/Md      PA/E/V      Dop.      ES      SSE
AO-10          255/ 59      112/ 26      35038/153/      5/0/V      0Hz      9      71
AO-13          323/ -0      204/ 47      39443/ 80/      9/0/      0Hz      9      143
FO-20          105/-42      359/-15      10316/200/      38/0/      0Hz      57     58
RS-10/11       188/-38      96/-49      9355/ 55/      43/1/      0Hz      60     38
RS-12/13       191/-75      253/-63      13299/ 29/      13/0/      0Hz      60     93
AO-21          13/-24      320/ 76      7193/163/      52/0/      0Hz      60    115
MIR            25/-70      279/  1      12361/171/      19/0/      0Hz      71    136
UO-11          178/-54      77/-77      11168/106/      32/1/      0Hz      65     54
UO-14          169/ 14      81/ 20      2080/174/      59/1/      0Hz      63     48
AO-16          348/-83      261/-23      13448/ 49/      6/0/      0Hz      63    130
DO-17          169/-41      66/-52      9514/124/      42/1/      0Hz      63     29
WO-18          349/-28      223/ 75      7443/234/      52/0/      0Hz      63    128

```

```

04:22:44 to LOS of AO-10          00:04:38 to AOS of AO-13
03:21:59 to AOS of FO-20          09:26:26 to AOS of RS-10/11
00:51:40 to AOS of RS-12/13      08:47:34 to AOS of AO-21
00:52:36 to AOS of MIR           09:06:54 to AOS of UO-11
00:12:04 to LOS of UO-14          00:46:46 to AOS of AO-16
00:17:11 to AOS of DO-17          01:15:23 to AOS of WO-18

```

Subfunctions(a,d,del,0)

+++++

PB/PG

The following information about the software in the PACSAT Protocol Suite is correct as of April 1994. As upgrades, changes or fixes are made, new versions will be distributed via AMSAT, the digital satellites and many BBS systems. The documentation included with the PB, PG, PHFADD and PHS software describe their functions in detail. This documentation was written by the authors of PB/PG. Often, another person's description is easier for user's to understand. Dave Hulatt, G4WFQ and Dave Medley, KI6QE have authored an alternative guide to the PACSAT software. Between these two versions you should be able to make PB and PG work for you. I encourage you to read the documentation and learn what is going on, do not just take someone else's BATCH files and let them control your system. Learn how the software works to make your system function better. There have been a number of utility programs distributed via the satellites to facilitate the operation of the digital satellites. There is work in progress to make these utilities more readily available to newcomers.

excerpt from

Pacsat Software Users Guide
by Dave Hulatt, G4WFQ and Dave Medley, KI6QE

=====

Release 1, 1st July 1992

4.0 Software Sources

4.1 The most reliable source for obtaining the software to operate on the Pacsats, is from the AMSAT-NA software exchange or from Amsat-UK. A donation to AMSAT is appreciated when you obtain this software which has required many thousands of hours of volunteer work for its preparation.

The addresses for these sources are as follows:

AMSAT-NA Software Exchange
850 Sligo Avenue
Suite 600
Silver Spring, MD 20910-4703
Tel 301 589-6062

Hon. Secretary
AMSAT-UK 94 Herongate Road
Wandstead Park
London E12 5EQ
England
Tel 081 989-6741
fax 081 989-3430

4.2 You may also obtain this software from an active user and it is hoped that you will, if not already, become an active financial member of your nearest AMSAT group.

...

5.5 Software: Your distribution disk, after unzipping, should contain the following files:

PB.EXE (Broadcast,Directories,Downloading) V. 920430p
PG.EXE (UPloading) V. 920225k
PFHADD.EXE (PACSAT Header add utility)
PHS.EXE (PACSAT file extract utility)
PGDONE.TNC (TNC re-configuration file)
PB.CFG
PG.CFG
PG.TNC
PB.EQN

6.0 Installing the Software

6.1 The simplest way to install the software is to create a directory on your hard disc called for instance "UoSat5" then copy all files from the distribution disc to this directory.

6.2 Example:

```
c:>md\uosat5
c:>cd\uosat5
a:>copy *.* c;
```

6.3 In the very simplest of systems it is even possible to run these programs on a PC with two floppy disks but your disks will fill up quite rapidly, especially if you use high speed data transfer. One of the authors used a dual floppy disk laptop for early experiments and to gain experience with UO-14 before investing in anything more elaborate.

6.4 A more elaborate file setup will be described later when advanced systems are covered.

7.0 Configuration Files

7.1 To complete the software installation you must edit the configuration files to comply with your particular system. These files may be edited using any text editor in Ascii mode. The Editor in DOS 5.0 is a good choice. If all else fails use "EDLIN" in earlier DOS versions.

7.2 PG.CFG

7.2.1 This configuration file is for PG only. The format of the configuration file is that each line contains 1 keyword followed by an argument. A separate PG.CFG file is required for each Pacsat. This is because the satellite callsigns will be different, as well as some parameters for each Pacsat. UPPER or lower case may be used.

7.2.2 The following keywords are valid. (speed, port, mycall, bbsscall, log, silent, maxdups, debug, max_backoff, backoff_slot, maxsel, myaddr.

7.2.3 Here we will only discuss the keywords which are essential for basic operations. These keywords have the following arguments and actions:

speed <baud rate>

sets the PC asynchronous port speed. Valid baud rates are 300, 1200, 2400, 4800, 9600 and 19200. Use 19,200 if you are working UO-22 or 4,800 for the slower speed satellites.

port <com number>

sets the communications port. Only Com ports 1 and 2 are valid. You will most likely be using COM1.

mycall <call>-<ssid>

sets your callsign. The SSID (Secondary Station Identifier) should be set at 0 at this time.

bbsscall <call>-<ssid>

sets the satellite FTL0 server callsign. Valid callsigns for active satellites are:

Satellite	Callsign
-----	-----
UoSat-5 Oscar-22	UOSAT5-12
Amsat-Oscar-16	PACSAT-12
Lusat-Oscar-19	LUSAT-12
Kitsat-Oscar-23	HL01-12
Kitsat-Oscar-25	HL02-12
ITALY-AMSAT-26	ITMSAT-12
AMSAT-OSCAR-27	EYESAT-12
PORTUGUESE-28	POSAT-12

7.2.4 There are other key words but we will not worry about them at this time and just let them default to their prescribed values

7.2.5 An example of a simple PG.CFG file for UoSat-5.

```
port 2
bbscall uosat5-12
speed 19200
mycall ki6qe-0
```

7.3 PG.TNC

7.3.1 PG.TNC is the TNC command file. You will need a separate PG.TNC file for each Pacsat that you intend to operate on. This is because you need to customize your TNC parameters to meet your own station requirements. Although when you run PG you will see an exchange of parameters to the TNC, some commands need to be customized. Those that you need to pay attention to are included in the example file below. If you are using TAPR 1.1.7 firmware it is a good idea to set AWLEN and PAR as this firmware defaults to 7 bits and even parity which will cause you to get error messages when you try and load PG.

7.3.2 An example PG.TNC file for UoSat-5.

```
awlen 8
par 0
fulldup on
frack 2
maxframe 3
paclen 180
pactime after 1
check 3
retry 10
txdelay 20
ackprior off
dwait 0
resptime 0
slots 1
txufram off
start 0
stopo 0
```

Probably the most critical of these parameters is the txdelay because it is very dependent on your hardware configuration. Generally the lower this number the faster your system will operate but if it is too low you will find your system slowed down with many retries. As shown above 20 is a good number to start with. If you have diode TX/RX changeover, you could try a lower number. For example an FT-736, without a linear in circuit. If your radio includes mechanical relays, or if there are any of these in the system, then txdelay will have to be a larger number.

7.4 PB.CFG

7.4.1 PB.CFG is the file which allows you to configure your Broadcast program (PB.EXE) and to select/reject the files to be transferred by the PACSAT. This is a most important file and its preparation can be quite complex and sophisticated. We will just discuss the most important things here and leave the details to the advanced sections to follow.

7.4.2 Valid entries in this file include:

```
mycall, alias, bdstcall, port, speed, pbpath, txdelay, restart_delay,
aea_delay, break_delay, silent, kisstnc, paclen, trace, tncid, ndupsearch,
maxpfhsize, logbbframes, logdbframes, logothers
```

mycall <call>

Your normal callsign. In this case do not use any SSID.

alias <string>

This is any other address you would like to be routed to you. For example you could put here a common mistake made with your callsign. If your call is, say, WA5YXA you might find that people frequently type W5YXA and this could be your alias. Or you might want always to get messages addressed to SATGAT and this could be your alias.

bdcstcall <call>-<ssid>

This identifies the satellite you want to use.

Valid entries here are

PACSAT-11
LUSAT-11
UOSAT5-11
HL01-11
HL02-11
ITMSAT-11
EYESAT-11
POSAT-11

port 1 or 2

This is the COM port to which your TNC is connected. COM1 and COM2 are only valid. Do not try to use COM3 or COM4. They will not work.

speed <baud rate>

This is the speed of the link between the TNC and your terminal. Do not confuse this with the speed of the link with the satellite. This speed should be 19,200 for UO-22 or 2400 for the lower speed satellites. If your TNC does not have 19,200 capability then use 9,600 baud but be warned your system may "hang" if you try to download a long file.

pbpath <dos path>

This is the path to the directory where you want PB to put downloaded files. Example C:\pacsats\uosat5 would put files in the uosat5 sub directory of the pacsats directory on C: drive.

These are the only entries we will need to make in this file at this time.

7.4.3 Example PB CONFIGURATION FILE (PB.CFG) FOR KI6QE

```
mycall KI6QE
alias SATGAT
bdcstcall uosat5-11
port 1
speed 19200
pbpath c:\uosat5
```

7.5 PGDONE.TNC

7.5.1 PGDONE.TNC is another TNC command file. However, this command file is used to send parameters to the TNC when you have finished running the PG or PB programs. Thus, here you can place any commands you wish to be executed when you want to transfer back to terrestrial operation. For example, you may wish to turn fullduplex off, or change the frack parameter. Again, this needs customizing according to your own station needs.

7.5.2 An example PGDONE.TNC file for UoSat-5.

(In this example, when you are finished on UoSat-5, set the TNC ready for terrestrial packet operation).

```
budlist off
mcom on
mcon on
monitor off
fullduplex off
frack 6
dwait 10
maxframe 4
paclen 128
check 30
retry 15
resptime 8
ackprior on
firmmr off
slots 3
txuifram on
start $11
stop $13
```

7.6 PB.EQN

7.6.1 This file allows custom configuring of PB to take care of the special needs of the user. This file is dealt with in detail in the Advanced concepts section of this manual. For the time being use this file in your current directory as is supplied with your distribution disc. With your editor change your callsign ONLY. This will permit the F keys to work as will be shown here and capture files addressed to your callsign and to ALL. It will not grab or display Gateway type messages in your general directory.

8.0 Program Usage

8.1 PB.EXE

8.1.1 PB.EXE is a program used for initiating and capturing broadcast files and directories. This is a totally different concept to that used in terrestrial packet systems. The Pacsat Broadcast Protocol distributes files of differing interests and we select and capture the files of interest. This capture may be carried out by request from your station or by interception of files already requested. In this way many stations may be served without occupation of connect time on the satellite. The only time it is necessary to transmit is to request files or directories which are not already being broadcast or to issue a hole fill request for missing parts of a file. PB.EXE uses the KISS mode in your TNC. Some older TNCs do not include KISS mode so be sure your firmware is up to date as described above.

8.2 PG.EXE

8.2.1 PG.EXE is a program used for "connecting" to the satellite. In this program we are using what is called "File transfer level zero" Protocol (or ftl0). PG.EXE uses TRANSPARENT mode in our TNC and also implements

the ftd0 ground station 'CLIENT' software. We connect to the satellite only to Upload files. Downloading is achieved with PB.EXE as just described above.

8.3 PFHADD.EXE

8.3.1 This is a utility program for adding a Pacsat File Header to your files so that they can be uploaded to the satellite with PG.EXE. The PACSAT header contains a lot of information concerning the file and is used in the Directory listing so that you can obtain this information before you download the file.

8.3.2 The PACSAT Header looks like this. Typical entries are in parentheses ().

8.3.2.1

1 -- Message I.D.	(42d9)
2 -- File size	(1740)
3 -- File Type	(0)
4 -- File name	(2A3EC0005)
5 -- Title	(CA1701A1.ZIP)
6 -- Key words	(Documentation)
7 -- Sender	(KI6QE)
9 -- Uploader Callsign	(KI6QE)
10 -- Destination	(G0K8KA)
11 -- Posted date	(06/17 04:31)
12 -- Expire Date	(06/20 02:15)
13 -- Priority	(0)
14 -- Compression Type	(2)
15 -- BID	(4221_KI6QE)
(This is only for BBS use).	
16 -- Body info	
17 -- Original name	(CA1701A1.IN)

PFHADD will ask you for the necessary information to fill in the blanks in the header. For the present use file type 0. The rest is self explanatory.

8.4 PHS.COM

8.4.1 This utility is used after you have downloaded a file to process and strip the header off the original file.

9.0 Putting it all together.

9.1 Before you can operate on a Pacsat, you will need to get the hardware in your station properly configured. It is assumed that you have the radio connected correctly. However, you must have the TNC set up for use on a Pacsat. Firstly, for the PG program you must have a full RS232 lead between your computer and TNC. That is one that has the following connections pin for pin:

GND TXD RXD CTS RTS DCD.

Consult your Computer and TNC manual for pin-out data but generally this is a standard modem cable available from most computer stores.

9.2 For PB only use you could have an RS232 which contains just GND TXD RXD but it is suggested you use the same standard cable referred to above.

9.3 Note your DCD line must indicate when your TNC is "connected". Some early PacComm TINY-2 TNC's incorrectly implemented the DCD connect line. A technical note describing a fix for these TNC's is available from PacComm. Also if you are using an AEA type TNC you may have problems with DCD which are generally solved by including DCDCONN ON in your PG.TNC file.

9.4 It is recommended that TAPR 1.1.7 or 1.1.8 firmware be used for reliable operation with this software. It works equally well in all but the oldest of TNCs (TNC-220 especially) and all TNC2s and clones including PacComm products. The PacComm firmware with numbers like P1.1.6D4 PMS-3.0 also works well but the TAPR is a later product and is more efficient.

10.0 Operating the Software

10.1 To send mail/files

10.1.1 Prepare your files.

10.1.1.1 Write your message or decide which "files" need to be sent. If you use a word processor to prepare your messages it is suggested you always store them in ASCII format and be sure there are no embedded Cntrl characters. It is also a good idea to turn your Word Wrap off and be sure there is a CRLF at the end of each line.

10.1.1.2 If your outbound file is larger than 2k always compress it using your favorite compression program. The most commonly used compression utilities are PKZIP and PKARC. There are others but before using them you should be sure your destination addressee has the capability to de-compress.

Compressing a file, using PKZIP.EXE is easy. For example:

```
C>PKZIP -m TOG4WFQ.ZIP TOG4WFQ.TXT
```

This takes the text from file TOG4WFQ.TXT and compresses it into a new file TOG4WFQ.ZIP

10.1.1.3 Add a Pacsat file header using PFHADD.EXE like this :-

```
PFHADD TOG4WFQ.ZIP (Where TOG4WFQ.ZIP = the "file.name")
```

PFHADD will ask you a series of questions concerning information to be included in the header of the message. Enter the originator and destination address. Pay particular attention to the message type. On this occasion you would select "0" for single message, then select "2" for PKZIP type file. Also give your outbound files a meaningful title and get used to using the key words as well. A discussion on message types will be found at Appendix A.

10.1.1.4 Having processed the outbound file, you will have a file TOG4WFQ.OUT in the directory. To send this file load the PG program with the sub commands -U - Q. (Type PG -U -Q). You do not have to do anything else to send your file. PG will do everything automatically for you with no input required from the keyboard. This is to keep the connected time down to an absolute minimum since other stations will be waiting to connect. When PG sees an "OPEN" status message it will attempt to connect to the Satellite and commence sending the file(s) which have been prepared with PFHADD. You can watch the progress of uploads on the screen as PG will keep you informed as to what is going on. When it has completed the upload of each file it will tell you the bytes/sec speed of the upload.

10.1.1.5 If for some reason the upload of the file(s) was not completed do not worry as PG will continue the same upload on the next pass. This is really where the PG (ftl0) program comes into its own. If your file called TOG4WFQ.OUT did not get completely uploaded for whatever reason (LOS etc) this file will be renamed on disc to TOG4WFQ.PUL PUL standing for partially uploaded file. Thus, when you continue the upload on the next pass, PG will search the current directory for files with the extension of.PUL then continue the upload at a specified point within this same file. Actually PG will always look for files with the extension of.PUL before searching for files with the extension of.OUT. When a file is completely uploaded it will be renamed on disc to file_no.UL. This is all you can do with PG.EXE now. All downloading and directory work is done with PB as will be described below.

10.1.2 To receive mail/files use PB.EXE

10.1.2.1 The advantages of using the PB (Broadcast Protocol) to broadcast and capture files are as follows:

10.1.2.1.1 You can obtain an updated directory by intercepting (grabbing) directory entries being broadcast.

10.1.2.1.2 You can request directory updates for yourself automatically with very little air time.

10.1.2.1.3 You can capture files the same way. If they are already being broadcast do nothing. Your program will grab it without transmitting.

10.1.2.1.4 You don't need to acknowledge (ACK) the packets. In fact, as already stated, you don't have to transmit at all if the file is already being broadcast.

10.1.2.1.3 While you are receiving a file "everyone" else in the footprint can do so as well.

10.1.2.2 So let us take an example of how to use PB.

10.1.2.2.1 We first need to get our directory updated. If you have set up your system as suggested just type PB and sit back. Your system will request a directory update, at the same time it will grab directory entries already being broadcast. At the bottom of your screen you will see the progress. On the left you will probably see a number like 03. This means that there are 3 holes in the directory to be filled. There will be a box in the center which will say DIR. This means the directory is being updated.

10.1.2.2.2 While this is happening you will see a list of callsigns running across the center of the screen. This is the queue and in it you should see your call with a /D after it like KI6QE/D. This means that a directory entry has been requested by KI6QE. You will see your call progress to the right and when it reaches the head of the queue you will receive your directory updates. Watch them come in the box on the top right of the screen.

10.1.2.2.3 Finally the left hand box will say Up-to-date and the center box will say Idle or perhaps it will contain a filename like 3cff. This means that file 3cff has been marked automatically for download because it meets some criteria set by you in the .CFG file. In this case it is probably addressed to your callsign or alias. You will also see your callsign in the queue but this time without the /D. When you reach the head of the queue file 3cff will be broadcast and if you watch the top left of your screen you will see its progress. If this is a short file it will almost certainly be finished in a single broadcast and you will hear two beeps from your computer.

10.1.2.3 While all this is going on you can examine the directory by using the V (View) key. This will list the directory and you will note that the files may have a g (grab) n(never) or perhaps an A or P against them. Those marked with a g will be grabbed if they are heard while those with an n will be ignored. The A means you have selected the file for download and the P gives the file some Priority in that it will be requested before A files. You can go ahead and change these markers manually at any time. As you will see later we can sort this directory in ways which you can select.

10.1.2.4 As the automatic operation continues you may see some rather cryptic messages in the center of your screen. The most common will be OK KI6QE. This means that it is acknowledging a request from KI6QE. Another one may be NO-1 KI6QE. This means that the queue is full (it has a maximum of 20 entries) and the request has not been entered. NO-2 KI6QE means that file is no longer available. Note that files generally remain available for a maximum of 5 days before they are auto-deleted. This is entirely dependent on the RAM space on board the PACSAT, and the lifetime of the file in the PACSAT File Header.

10.1.2.5 When the satellite goes down the automatic operation will cease. When you exit from the program (type Q) all received fragments (incomplete files) will be saved and the TNC will be returned to normal operation.

10.1.2.6 You should now find a file or files in your current directory with the extension (EXT) .DL meaning downloaded file. These files require processing before you can use them.

10.1.2.6.1 First we need to remove the PACSAT header and extract the main body of the message. This is done by using PHS.COM. Using our same file TOG4WFQ, only now it is TOG4WFQ.DL, we type

PHS TOG4WFQ.DL /X

The /X means to extract the text from the header. As this process continues you will see a printout on your screen of the contents of the header and finally the name of the extracted file will be typed. In this case it will be TOG4WFQ.ZIP.

10.1.2.7 Now we must decompress the file to get a readable text so we type PKUNZIP TOG4WFQ.ZIP and we will now have an ASCII machine readable file called TOG4WFQ.TXT .

10.2 PB Function (F) keys

10.2.1 The PB F are already programmed in the PB.EQN file referred to above and will function as follows:

10.2.2 While PB is loaded, even if the satellite is not in view, pressing the V key (View) will display the Directory in various forms, controlled by the F (Function) keys. The following table shows the particular displays:

KEY	Display
F1	All the MAIL files
F2	Your personal Mail
F3	All Bulletins
F4	Satellite Logs
F5	Files downloaded
F6	Files requested
F7	Keplerian Elements
F8	Image Files
F9	News Files
F10	PB/PG Files
F11	BBS Gateway Files
F12	Urgent Priority Files

So in effect, after you have pressed the V key, the F keys will extract selected files from the directory and display them for you. How you can design your own configuration will be shown later.

12.0 Good Operating Practices.

12.1 So far you have learned enough to get the basic configuration done and allow yourself to get directories,download files and upload files. This program is highly automated and there are some matters to be considered so as not to take up excess satellite time and allow all maximum use and enjoyment. So here are some suggestions:

12.1.1 We all learned when we first became hams "Listen before you transmit". This is true in any communications environment so before you request a broadcast watch what is already being broadcast and if the file you want is being processed wait until it is say 90% complete and then request a hole fill. This is especially important for long files such as image files.

12.1.2 Try and keep your directory updated on a daily basis. This way you will not occupy the queue for long periods getting directories.

12.1.3 If you have a long file to upload, say more than 10K, do this on off hours when the satellite is not too busy. This way you will not remain connected for long periods in rush hours thus allowing as many as possible to use the satellite facility.

12.1.4 Always leave Grab on. This way you will get the most of files being broadcast and avoid making unnecessary broadcast requests.

PART 2 - MORE ADVANCED CONCEPTS

1.0 A Better Directory Arrangement.

1.1 In Part 1 we described a simple directory system wherein all the files were contained in a single directory. This is fine so long as you only want to work with one satellite but if you want to use multiple satellites it is better to use a more elaborate directory system.

1.2 It is a good idea to put all the files that are common to all satellites in one directory and then create separate sub directories, one for each satellite. In these sub directories will be placed all the files related to that particular satellite including the message files.

1.3 First we create a directory which we will call SEXE. (No this is not what you think. It means "Satellite EXEcutable files). Into this directory we will put the following files:

PB.EXE
PG.EXE
PFHADD.COM
PHS.COM
PKZIP.COM
PKUNZIP.COM

We must also be sure that this directory is included in the PATH statement which you may have in your autoexec.bat file. If you do not have this you should include the following line in that file:

PATH = C:\;C:\SEXE

1.4 Next we will create a sub directory for each satellite under SEXE. Let us call these sub-directories UOSAT,PACSAT,LUSAT.

In each of these directories we will place the following files:

PB.TNC
PG.CFG
PB.CFG
PB.EQN

making sure that each of these files is configured appropriately.

1.5 Now to start, for example, PB for UO22 we would enter the UOSAT sub directory and type PB. It is important to be sure you are logged into the UOSAT sub directory before typing PB.

1.6 Using this system of sub directories we can keep files for each satellite separately thus avoiding much confusion which would arise if we attempted to do it all from a single directory.

2.0 More on PG.CFG

2.1 In Part 1 we discussed just enough topics to get a system running but there are more parameters which we can set to fine tune the system to do exactly what we want. The following paragraphs tell us about the other key words not covered in previous discussion.

log 0

During operation, PG creates and appends to a file called PG.LOG. This file tends to become large and occupy a lot of memory but is useful as a record of what has transpired. If you don't want it set log 0.

silent 1

From time to time PG will produce beeps to announce connection and completion and other accomplishments. If this annoys you for any reason you can suppress it by setting silent 0

disc_delay <seconds>

PG will force a disconnect from the satellite if it has not received an acknowledgement after a fixed number of seconds set by this parameter. The default is 10 seconds and you should probably not change it unless you have a good reason to do so.

debug <n>

This enables you to monitor what is going on or to shut off a lot of the stuff that you don't want to see. n is what programmers call a hex number but we will make it simple and specific.

n = 3 - This will cause an output of ALL received bytes and is only used for debugging a TNC interface. If you are using a PC don't try this as your machine is too slow.

n = 1 - This allows the user to verify any change from connected to disconnected status. This is used particularly for overcoming problems with flickering CON DCD on your TNC. Try debug 1 if you have this problem.

2.2 A better PG.CFG file.

```
port 1
bbscall uosat5-12
speed 19200
mycall ki6qe-0
log 1
silent 0
disc_delay 20
debug 1
```

3.0 More on PB.CFG

3.1 In Part 1 we discussed the minimum requirements for PB.CFG but there is more to it that we have seen at this point. The next set of parameters to be discussed are related to idiosyncrasies of various TNCs and this will give you some guidance if you experience problems in interfacing a particular TNC.

txd <tx keyup delay msec>

This is the number of millisecs between the keying of your transmitter and the start of transmission of data. This was discussed a little under PG set up. The default here is 150 millisec but 400 is probably a better number to start with. After you have got your system working reduce this until you get best results.

restart_delay <delay after restart command is sent>

When you start PB it sends a series of commands to the TNC to get it into KISS mode. The last command sent is RESTART and this causes the TNC to do many things, including flashing the lights on its front panel three times.

All this takes time so if the restart_delay is too short the TNC will not be able to accept the next command. Each increment of one in this parameter represents an interval of 1/18 second. A value of at least 60 (3.33 secs) is recommended but you must tailor this to your particular TNC. It is not particularly critical so long as it is not too short. If it is too long it just means you will have to wait a while longer.

aea_delay <delay before restart command>

Some "SMART" TNCs will not go into KISS mode unless this delay is set. If you are having a problem try increasing this number (a lot) to say 20. The default is 1 (.055 secs)

break_delay <delay after a BREAK command>

After a break command is sent to the TNC it needs some time to get its act together before receiving additional commands. The default is 9 (0.5 sec) but your TNC may need more time. If things go haywire after a break try increasing this parameter.

silent 0 or 1

If the beeping bugs you set silent 1. The default is 0 which means it does a lot of beeping.

kisstnc 0 or 1

Some TNCs have KISS EPROMs installed. This means that the TNC is always in KISS mode and thus we don't need to waste time trying to put it into KISS mode. Set kisstnc to 1 in this case. Similarly if, for any reason, you need to manually put your TNC into KISS mode before starting PB then set this to 1. The default is 0.

paclen <bytes>

This is the length of the packets the satellite will send you in Broadcast Mode. The default is 244 which is OK for the high speed satellites but you might find 140 more reliable for the slower speeds.

trace 0 or 1

This is used to monitor connected activity on the downlink and is mostly useful for command stations. Default is 0 which means that it is inoperative.

3.2 File blocking and selection.

3.2.1 This is the heart of the PB system and needs to be understood well in order to make maximum use of the satellite facility. It is important for ALL users to work with maximum efficiency so that as many packeteers as possible may enjoy satellite communications vis packet radio.

3.2.2 There are two things that we can do and they are quite separate and independent.

3.2.2.1 First we can "block" files. This means that files of the type indicated in the blockftype entry(s) in the PB.CFG file will never be grabbed. This only applies to files (or parts of files) that are heard before the file appears in the Directory listing. When the file is recorded in the Directory, then it is up to the NEVER section in the PB.EQN file to determine whether the file should be grabbed or blocked. No Directory entry is ever blocked. For example suppose you have

blockftype 2

in your PB.CFG file and there is a file type 2 on the satellite addressed to your station but you have not yet received the directory entry for it your system has no knowledge of this file. BUT if another user requests a broadcast of this file your system will block it even though it is addressed to you. It is only after the receipt of the directory entry that it is determined that the file is addressed to you and the blockfile entry will be over ridden by the relevant equation in the PB.EQN file. Therefore before you make any of these entries be sure that you will NEVER NEVER want files of this type.

3.2.2.2 The other thing we can do is to "View" Directory entries from the received directory by use of the function (F) keys. This is really a sort procedure that sorts the directory into various categories as determined by the equations you will write and put in the .EQN file.

3.2.3 So let us now see exactly how these two concepts are applied in practice.

3.3 A final entry in the PB.CFG file to be discussed is blockftype. An entry of blockftype n in this file will result in no files of type n being grabbed prior to the entry being received in the Directory. (For a listing of the various filetypes, please refer to Appendix A). For example:

blockftype 1

blockftype 2

would insure that no BBS files would be grabbed. A maximum of twenty entries of this type are allowed.

3.4 There are a number of other parameters associated with PB but their use and significance is so obscure as to be of interest only to the highly skilled. People in this category will get the information they need from the University of Surrey documentation.

3.3 A better PB.CFG file.

```
mycall KI6QE
alias SATGAT
bdcstcall uosat5-11
port 1
speed 19200
pb path c:\uosat5
act days 3
txd 150
paclen 244
exitafter 5
blockftype 1
blockftype 2
```

This will block all BBS files being grabbed unless you write an equation to override this requirement. See discussion above.

3.4 The .EQN file and its uses.

3.4.1 PB now contains another setup file, PB.EQN. This is an ASCII file which contains equations to describe more precisely what you want PB to do for you. These descriptions take the form of equations written in a style typical of many computer programming languages and here we will try to describe the process in more layman's terms.

3.4.2 The .EQN file is in two parts. The first part sets out what you would like the Function (F) keys to do for you in displaying the directory in various forms and the second part allows you to select what you want downloaded from your directory automatically. You can also select the type of files you would like to give the status NEVER.

3.4.3 An equation is always in parentheses and individual statements within the equation are also in parentheses. An example may make this clearer.

```
( F1 (destination = ALL)
)
```

This is the simplest equation possible and this will make your directory display show all messages addressed to ALL when you press the F1 key. Note that the opening and closing parentheses are on separate lines.

3.4.3.1 Now lets dress this up a little and write it like:

```
F1 "All Mail" keytitle
( (destination = ALL)
  or
  (destination = KI6QE)
)
```

Now when we press the F1 key we will see the directory entries for mail addressed to ALL or to KI6QE and at the bottom of the screen will appear the title "ALL MAIL".

3.4.4 Now supposing we would like to make this a little more specific and have the F2 key display just files titled IMAGE and addressed to ALL. Our equation would look like this:

```
( F2 (destination = ALL) & (title = image) )
```

This means that before a directory entry is displayed the file must be addressed to all AND have the title Image.

3.4.5 A more complex equation might look like this:

```
( F3
  (
    (destination = ALL)
    |
    (destination = KI6QE)
  )
  & (filetype <> 1) )
  & (filetype <> 2)
```

What this says in plain English is "Display files addressed to ALL or to KI6QE but not if they are type 1 or type 2 files" when I press F3. Remember type 1 and 2 files are BBS files. The symbol "<>" means "is not equal to", "&" means and and "|" means or. This is computereze and future editions of PB will certainly include the use of the words and or etc..

3.4.6 You may include up to 12 equations of this type in the PB.EQN file. Now go back and look at the following PB.EQN file and you should be able to understand what the F key entries mean.

3.4.5 This is the sample equation file.

```
(F1 "All Mail" keytitle
  ( (file_type<=>2) and
    ( (file_type<200) or
      (file_type=255)
    )
  )
)
(F2 mycall keytitle
  ( destination=(*+mycall+*)
  ) or
  ( destination=(*+alias+*)
  )
)
(F3 Bulletins keytitle
  (destination=*ALL*
  )
)
(F4 Logs keytitle
  (file_type>200) &
  (file_type!=255)
)
(F5 Done keytitle
  maskdone
)
(F6 Requested keytitle
  maskauto
  maskpriority
)
(F7 Keps keytitle
  (file_type=8) |
  (file_type=9)
)
(F8 Images keytitle
  (file_type=211) |
  (keywords=*IMAGE*)
)
(F9 NEWS keytitle
  (keywords=*NEWS*)
)
(F10 PB/PG keytitle
  (keywords=*PB*) |
  (keywords=*PG*)
)
(F11 BBS keytitle
  (file_type=1) |
  (file_type=2)
)
(F12 Urgent keytitle
  (precedence>0)
)
(auto
  ((destination=ALL) and
  ((file_type=8) or (file_type=9)))
)
(priority
  (destination=(*mycall*)) |      PUT YOUR CALL AND ALIAS IN HERE
  (destination=(*alias*))
)
never
  (file_type=2)
)
```

Weberware v3.0

As you can see from the example screen below, WeberWare will allow you to do nearly anything you can think of with the 1200 bps PSK satellites downlink. This is an excellent program to have and is available from AMSAT. Now only can you switch between it and your tracking program, but you can capture, observe, graph and save to a file automatically. After the pass you can reconstruct the latest Earth image broadcast by WEBERSAT. It is a good challenge to try to capture 100% of a WEBERSAT photo image.

Figure 13. WeberWare V1.3 Main Screen

F1	Quick-Track	Sh-F1	Instant-Track
F2	Packets -> B&W Picture	Sh-F2	Extract Packets
F3	Merge B&W Picture Files	Sh-F3	Print Documentation
F4	Guess At Missed Pixels	Sh-F4	AO-16/LO-19/UO-22 Menu
F5	Display B&W Picture	Sh-F5	Convert to GIF
F6	B&W->Colorized Picture	Sh-F6	Display GIF's
F7	Display Colorized Pic	Sh-F7	Time Conversions
F8	Capture Webersat data	Sh-F8	Command Fill Spectra
F9	Erase Data Files	Sh-F9	Command Fill Picture
F10	Quit WeberWare 1.3	Sh-F10	About WeberWare 1.3
Ctl-F1	Decode Misc. Packets	Alt-F1	Packets -> Spectra
Ctl-F2	Extract TLM	Alt-F2	Merge Spectra
Ctl-F3	Graph TLM	Alt-F3	View Spectra
Ctl-F4	Text TLM	Alt-F4	TLM Database Extractor
Ctl-F5	Spreadsheet TLM	Alt-F5	Decode MBL Telemetry
Ctl-F6	Find WOD	Alt-F6	Merge Double Field Pics
Ctl-F7	Extract/Sort WOD	Alt-F7	Display Double Field Pic
Ctl-F8	Graph WOD	Alt-F8	Commands Menu
Ctl-F9	Text WOD	Alt-F9	Display Headers
Ctl-F10	Spreadsheet WOD	Alt-F10	Shell to DOS

SatSked

Below is a sample screen of SatSked. This program is used to automate your station. The actual program is available from a number of BBS sources, but a donation to AMSAT and a request will get you the 'key' to turn it on.

Figure 14. Sample SatSked program screen

```

Thu Apr 21 02:32:03 UTC+0
Next:   ko-23 00 00:14:30
Last:   ko-23 1 20:43:47
Commands Page 1 of 5:
Tab go to page 2 of 5
Pass Window Scrolling:
PgUp PgDn Home End
^X ^Y
More Commands:
+ - Change next pass
b <B>eep
c Edit <C>onfig. data
d NC
e <E>dit pass data
g <G>enerate pass data
k <K>ill current pass
m compose <M>essage
p Edit <P>riority data
x E<X>it SatSked

```

#	P	Bird	Date	AOS Time	LOS Time	El	Abort at
1	3	ko-23	21APR94	02:46:33	02:57:03	15	
2	2	ko-25	21APR94	03:04:25	03:14:57	39	
3	1	uo-22	21APR94	04:16:51	04:27:28	44	
4	3	ko-23	21APR94	04:40:22	04:57:34	65	
5	2	ko-25	21APR94	04:45:02	04:53:42	21	

Bird	Azim	Elev	E Range	dR/dt	MA	Time/Alt
ao-10	277.2	0.6	^X 10174	-4.2	248	00:08:26
ao-13	325.4	-8.0	^Y 28830	2.6	41	09:47:34
ao-16	142.3	-32.5	^X 8128	-5.3	234	01:52:59
do-17	308.1	-63.1	^Y 12262	2.7	125	00:57:31
lo-19	61.6	3.0	^X 2953	-0.6	29	01:33:36
fo-20	244.6	-36.3	^Y 9454	4.2	59	06:34:37
ao-21	155.3	-21.0	^X 6595	-5.4	69	00:12:44
uo-22	140.1	-13.6	^X 5034	-6.2	187	00:07:27
ko-23	315.7	-21.8	^X 7310	-4.6	85	00:14:28
ko-25	173.2	-65.8	^X 12477	-2.6	196	00:32:24
io-26	112.7	4.9	^X 2774	-4.9	3	00:01:07
ao-27	157.7	-43.1	^X 9785	-4.8	206	00:21:01
posat	192.0	-75.8	^X 13175	-1.3	166	00:38:24
mir	47.6	-12.5	^Y 4070	6.6	202	04:41:30
rs-10/11	163.6	-52.5	^Y 11296	3.6	53	01:07:24

Ta: 0	Te: 0	NO DATA
Ca: 58	Ce: 0	AE


```

KX4Y
SatSked 1.937 de WA2N

```

SATELLITE GATEWAY OPERATIONS

Roy W. Welch, W0SL

When Packet Radio first started operation, it was essentially on the VHF bands and thus, restricted to line of sight operation. This range was extended by the installation of mountain-top digipeaters, and before long, many states had good coverage through networks of digipeaters.

However, any long range relaying of traffic, particularly Bulletin Board Traffic, took a long time and many places were not reachable at all. For example, it was not possible to send a packet message from East to West or even from California to Texas.

So Amateurs began experimenting with packet on the HF bands, and although limited by regulation to 300 bps (bits per second), worldwide coverage was soon obtained and packet messages began to be transmitted over long haul distances. The HF stations providing this service became known as "Gateways" because they provided a gate through which traffic could pass, destined to locations inaccessible by VHF routes.

Other Amateurs began experimenting with new HF modes, such as AMTOR, to provide gateways to far distant locations. This system works well and provides a good service worldwide, but suffers from all the vagaries of HF transmission. In periods of poor propagation, traffic delays of weeks and even months have been experienced in various parts of the world.

The advent of the Microsats in 1989 and the subsequent development of their capabilities presented a possible solution to the HF delay problem. This was first recognized by an Amateur BBS SYSOP in Anchorage, Alaska. He had been through the earthquake in Anchorage and experienced the frustration of being unable to pass his Emergency (ARES/RACES) traffic via HF to destinations in the USA. In conversations with an AMSAT VP in early 1990, they developed the concept of using PACSAT, AO-16, as a store and forward message system between Alaska and California. This would be particularly valuable in an emergency situation, such as an Earthquake or other natural disaster.

So the services of another Amateur in California were obtained and satellite gateways were opened in Anchorage and Los Osos, CA, using PACSAT. BBS personal message traffic began passing over this route regularly in late February 1990. The efficiency of this system was soon demonstrated and both gateways developed systems to interface PACSAT with the terrestrial packet network.

Other Amateur operators noted this experiment, and soon requests were coming in from them wanting to join in and pass traffic to many distant locations. By the end of 1991, there were 30 satellite gateways world wide, many of them automated, and all interfacing with local networks. Traffic volumes of up to 100 messages per day now pass through some of these gateways.

Soon it became apparent that it was unwise to depend on one satellite for this service and LUSAT started being used with the active support of AMSAT Argentina. Later, others began experimenting with satellite UOSAT3 (UO14) using 9600 bps data rates, until Amateur

operations were moved from that satellite to UOSAT5 (UO22). Now most gateways use this mode with LUSAT as a backup.

GATEWAY MESSAGES

Messages may be forwarded via any of the gateway stations using normal packet addressing procedures. Obviously this type of gateway is intended for long haul traffic, not for traffic going across the state. Terrestrial networks are better suited for this type of traffic. No bulletins except those of general Amateur interest and no foreign NTS type traffic will be accepted for forwarding by the gateways.

If you live within range of one of the listed gateways, or can reach it via digipeaters, then just use normal packet addressing procedures. It is most desirable to use this "direct" addressing if at all possible, so you should encourage your SYSOP to include this facility in his BBS. If you cannot reach a gateway directly, then check with your local SYSOP. In most areas, you can still use one of the satellite gateways even if you are not within "range" of one.

If your BBS does not route foreign traffic through a satellite gateway, you as an individual, can use what is called a REQSAT (Request Satellite) server at most gateways to route your mail through the gateway automatically. The REQSAT server software is provided for use at the gateways courtesy of Chris, G6FCI.

You will need to format the message you wish to send in a particular way. As an example, you want to send a message to Jim, 4X1AB, who receives his mail at the 4X1YZ BBS. In this example, let's assume that the N0GIB gateway is the gateway nearest to you. At your BBS prompt send your message as follows:

SP REQSAT @ N0GIB.#SESD.SD.USA.NA	[REQuest SATellite at the N0GIB gateway.
Rig Trouble Here	[Enter the message subject as normal.
SP 4X1AB @ 4X1YZ.ISR.MDLE	[Enter the REAL address as the FIRST
Hi Jim the rig has been....	[line of the message. A SPACE MUST exist
text text etc.....	[between SP and the first callsign.
/EX	[Do NOT omit SP on the REAL address line.

Use the full Hierarchical address of the destination station, as shown above. It will be needed to correctly route your message.

So to sum up, at your own local BBS prompt enter:

SP REQSAT @ N0GIB.#SESD.SD.USA.NA

When asked for the subject (or title), enter whatever you like, such as:

TNC problems again!!!

Do not omit this line or leave the subject blank! When asked for the Message the VERY FIRST LINE must contain the real address, including the Hierarchical Address, such as:

LINE must contain the real address, including the Hierarchical Address, such as:

SP 4X1AB @ 4X1YZ.ISR.MDLE

Do NOT put anything else on this first line!! Then on the following line, enter the rest of the message as you would normally, ending with the usual:

/EX

When the message arrives at the gateway it will be automatically re-addressed according to the first line of the message, the subject you entered will be the same and ALL the headers will remain, so anyone doing a SR reply will have the reply sent back to the BBS on which you entered the message. The gateway will automatically route your message to the appropriate destination gateway based on the country designated in the REAL address.

A current (4/94) list of available gateways follows on the next page. Watch for bulletins to provide updates from time to time.

Current (4/94) List of Digital Satellite Gateways

Satgate	Sysop	@BBS	Service Area
NORTH AMERICA			
W9HGI	W9HGI	@ AA4RE.#NOCAL.CA.USA.NA	CA, UT, ID, NV, AZ
NL7NC	NL7NC	@ KL7AA.NAK.AK.USA.NA	AK, VY1
VE8DX	VE8DX	@ VE8DX.#BAF.CAN.NA	Baffin Island only
W0SL	W0SL	@ W0SL.#STL.MO.USA.NA	KS, MO, IL, IA, CO, AR
NU9H	NU9H	@ NU9H.#NWIN.IN.USA.NA	IN, IL (Chi. Area), MI, KY, WI, VE3, 4
NR3U	NR3U	@ NR3U.#NCPA.PA.USA.NA	PA, NJ, OH, MD, VA, WV, DC, NY
WB2VPH	WB2VPH	@ WB2VPH.#WNY.NY.USA.NA	MA, ME, DE, VT, RI, NH, CT, VO1, VE1, 2
N0GIB	N0GIB	@ N0GIB.#SESD.SD.USA.NA	SD, ND, WY, NE, MN, MT, VE4, 5
WB5EKW	WB5EKW	@ WB5EKW.#WTX.TX.USA.NA	TX, NM, OK
KG4TM	KG4TM	@ KG4TM.CUB.CAR.NA	Guantanamo, Caribbean area
WH6AQ	WH6AQ	@ WH6AQ.HI.USA.OC	US Possessions Pacific Area
N8DEU	N8DEU	@ KK4UZ.#HSV.AL.USA.NA	AL, LA, MS, GA, TN, NC, SC
N7RSN	KB7CNN	@ N7RSN.WA.USA.NA	WA, OR, VE6, 7, 8
AB4RB	AB4RB	@ AB4RB.FL.USA.NA	FL, Central America
XF3R	XF3R	@ XF3R.#CUN.QR.MEX.NA	Mexico
EUROPE			
ON4KVI	ON4KVI	@ ON4KVI.LU.BEL.EU	Belg, Germ, Aust, Lux, Den, Neth.
EI6EH	EI6EH	@ EI6EH.#KELLS.IRE.EU	Ireland, part of UK
EA3RAC	EA3RAC	@ EA3DXR.EAB.ESP.EU	Spain, Portugal
OH6SAT	OH6KG	@ OH6RBI.FIN.EU	Finland, Sweden, Norway
GB7LAN	G8TJZ	@ GB7LAN.#16.GBR.EU	Most of UK
TF3LJ	TF3LJ	@ TF3LJ.ISL.EU	Iceland
F6CCD	F6CCD	@ F6CCD.FMLR.FRA.EU	France, Switzerland, Italy, Turkey,
SV8RV	SV8RV	@ SV1IW.GRC.EU	Eastern Europe, Russia, Ukraine, India, Pakistan
OCEANIA			
ZL2AMD	ZL2AMD	@ ZL2AMD.#40.NPE.NZL.OC	New Zealand
VK5SPG	VK5KDC	@ VK5KDC.#ADL.#SA.AUS.OC	VK5, 6, 8
VK4BBS	VK4BBS	@ VK4BBS.BNE.QLD.AUS.OC	VK3, 4, 7, 9
VK2XGJ	VK2XGJ	@ VK2XG.NSW.AUS.OC	VK1, 2, South Pacific
W1YRM	W1YRM	@ KH2D.GUAM.USA.OC	Guam, Philippines, Hong Kong, Marshall Is., JNET3 Japan
MIDDLE EAST			
4X1RU	4X1RU	@ 4X1RU.ISR.MDLE	Middle East
FAR EAST			
JA6FTL	JA6FTL	@ JA6FTL.JNET6R.JPN.AS	Korea, Taiwan, Indonesia, Sri Lanka, Singapore, China, Thailand, India, Macao, JNET6R Japan
JA0CBY	JA0CBY	@ JA0CBY.08.JNET0.JPN.AS	Mainland Japan
AFRICA			
ZS1ABM	ZS1ABM	@ ZS0STB.CP.ZAF.AF	South Africa, Zimbabwe, Namibia, Swaziland, Mauritius, Rwanda
SOUTH AMERICA			
PY2GN	PY2GN	@ PY2GN.SP.BRA.SA	Brazil
CX5AE	CX5AE	@ CX5AE.MVD.URU.SA	Uruguay
LU8DYF	LU8DYF	@ LU8DYF.OLIVOS.BA.ARG.SA	South America except Brazil & Uruguay

Automatic Station Set-up for the 9600 bps Satellites

Dieter K Schliemann, KX4Y
1803 Roseberry Drive
Scottsboro, AL 35768-3634

Home phone (205) 259-3900
Work phone (205) 574-7046
Compuserve 70402,2264
INTERNET kx4y@amsat.org

My station uses the following hardware:

IC-275H	-	2m all-mode transceiver
IC-475H	-	70cm all-mode transceiver
Hygain	-	2m/70cm cross yagi antenna set
G-5400G	-	Yaesu az-el antenna rotator
DSP-12	-	LL Grace TNC
KCT/T	-	LL Grace Kansas City Tracker/Tuner
486dx33	-	IBM compatible computer with harddrive

All of my equipment is connected to and controlled by my computer.

I use the following software:

SatSked version 1.937 by Wayne Roth WA2N
PB/PG by Jeff Ward and Joe Barker
KCT 5.21 by Joe Barker N6KK
View Dir by Chris ZL2TPO

and some other very useful peripheral programs related to using 9600 baud microsats, written by various satellite enthusiasts around the world.

My station runs around the clock, every day. I check my mail twice a day that got downloaded automatically since I checked my mail last. I check my computer clock for correct time every two or three days. I correct the time, if the time is off by more than 1 second. I give my system new keps every week as I receive new keps off the birds.

That is all I need to do to keep my system running around the clock, monitoring UO-22, KO-23 and KO-25. I also monitored and communicated through POSAT while it was available for ham radio communications.

Description of automatic operation.

SatSked automates and manages the operation of my station. SatSked reads the keplerian elements file, and calculates pass data for each satellite that I asked it to track. At the beginning of a pass of a satellite that I want it to track,

SatSked:

Switches my TNC into the correct mode for that satellite by using the DSPMODE program.

Executes the orbitdrv.exe (supplied with InstantTrack) program to continuously provide antenna pointing and radio tuning information to the KCT/T via the KCT 5.21 program.

Switches to the computer subdirectory of that satellite, and starts PG/PG as determined by whether or not I have files for uploads in that satellites subdirectory. If I have upload files ready, it goes into PG (up-load mode), if not, it goes straight into PB (down-load mode).

After a satellite pass is finished, the computer goes back to the SatSked menu and waits for the next satellite. SatSked tells you how long you have to wait for the next satellite pass, while it gives you status of all the other satellites that you may be interested in. For example, it tells you how long to wait for the next AO-13 pass or how long it still will be there if it is up. Just as QuikTrak does. After a user selected time, SatSked goes into the screen saver mode, but the screen saver still tells you how long to wait for the next pass.

Notes on equipment

Transceivers

It is most desirable, to only use equipment with provisions to communicate with computers. In addition, one needs to be sure that available software supports the equipment. For example: The IC-970 is not supported by the available KCT programs, the Yaesu FT-736R is, and so are the IC-275/475 ICOM transceivers.

TNCs

The DSP-12 by LL Grace is very popular and has been used for a few years now. AEA now also sells a fine DSP type TNC that works well. Regular TNC2 type TNCs like the MFJ-1270B can be used with a 9600 baud modem installed. The DSPs lend themselves for automatic computer controlled switching between different speeds and modes, TNC2 based stations need to switch manually.

Tracking and tuning devices

The KCT/T from LL Grace has been around for a few years and seems to be widely used. The Trakbox, available from TAPR in kit form seems to work well also, but requires assembly. Both devices are supported by SatSked.

Antenna rotators

The azimuth and elevation rotators need to be capable of being controlled by the KCT/T or the Trakbox. The Yaesu G-5400B is very easily interfaced with the KCT/T.

Notes on automated station software

PB and PG are sufficient to communicate with the 9600 baud microsats.

The KCT/T comes with LL Grace software, and can be used for antenna tracking and radio tuning by using satellite pass information tables created by satellite tracking programs, such as Quiktrak. With that, one can communicate with the microsats in the manual control mode.

For fully automatic station operation, a program to select the satellite, control the antennas, set the receive frequency and execute PB/PG are needed. These next three programs will do the station control.

SatSked for example, keeps your computer clock accurate while running in Satsked, and lets you shell into other programs like a satellite tracking program or your favored editor. SatSked is available from the digital satellites, AMSAT and many BBSs. A contribution to AMSAT and a request will give you the key to make it operational.

SAS by Tim KG4TM and the new arrival

WISP by Chris ZL2TPO are other programs that work very well also.

These are utility programs that perform useful functions:

View-Dir by ZL2TPO, to process and read downloaded files, there are programs to allow you to read user data bases that are posted on the birds from time to time.

PBCALL - PBCALL allows you to highlight your call sign in the color of your choice with the color of your choice, so you can easily spot whether or not you made it into the que.

At the moment, almost all of this software is distributed via the 9600 baud microsats. The software is available on diskette from friends. For someone new trying to set up for the microsats, it is best to contact the local AMSAT area coordinator for advice and help in locating the required software.

=====

Release 1, 1st July 1992

APPENDIX A - FILETYPES

- 0 ASCII text
- 1 RLI/MBL message
- 2 RLI/MBL import file (multiple messages)
- 3 UOSAT whole orbit data
- 6 MSDOS .EXE file
- 7 MSDOS .COM file
- 8 Keplerian Elements (NASA format)
- 9 Keplerian Elements (AMSAT format)
- 10 DELETED
- 11 DELETED (?)
- 12 Multiple files (one or more non- ASCII)
- 13 Multiple files (all ASCII)
- 14 GIF format
- 15 PCX format
- 16 JPG format
- 17 Confirmation Message (to be described later)
- 200 Config. files U/L from command stations
- 201 AL FTL0/PB activity logs
- 202 BL broadcast logs
- 203 WD whole data logs
- 204 ADCS logs
- 205 TDE data
- 206 SCTE data
- 207 Transputer logs (including EISLOG)
- 208 SEU logs (ELTLOG)
- 209 CPE files (UO3)
- 210 Battery charge logs
- 211 Image files

excerpt from Pacsat Software Users Guide
by Dave Hulatt, G4WFO and Dave Medley, KI6QE

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Release 1, 1st July 1992

APPENDIX B - File Blocking and Selection

The distinction between blocked file types and selection equations is crucial, and must be understood to make best use of the satellite facility. This Appendix seeks to provide more amplification for those who want to dig deeper without having to get into the great amount of detail in the University of Surrey Documents.

First let us understand some basic definitions.

PFH = directory entry.

FILE_TYPE = the file type indicator in the PFH.

AUTO = a message for which the select equation AUTO is true

URGENT = a message for which the select equation

URGENT is true

NEVER = a message for which the select equation NEVER is true

GRAB = a message which is not NORMAL, PRIORITY or NEVER.

This is a summary of what actually goes on:

1. Every broadcast data packet tells you the FILE_TYPE of the file being broadcast.
2. If you have not yet received the directory entry for the file, all you know about the file at this stage is the FILE_TYPE.
3. In the process of receiving a directory you can filter out FILE_TYPES you are not interested in by blocktype entries in PB.CFG.
4. After you have received the directory entry for the file, you know everything there is to know about the file, and you can submit it to a SELECT equation and see whether it is AUTO, URGENT, NEVER or GRAB.

To do all this effectively it is assumed that:

A. You have a lot of disk space.

B. With few exceptions, FILE_TYPE alone does not tell you whether might eventually want to read a particular message.

C. There are exceptions to B.

D. The broadcast protocol is at its most efficient if you NEVER throw away a packet that you later decide you want.

Now let us see how this works step by step:

A packet for FILE_NUMBER=N arrives, with FILE_TYPE=T.

We examine this packet to see if we already have an entry for file N. If we have it will be recorded in a file called SLIST which will tell us to do one of several things as follows:

1. It may already have been DOWNLOADED; In this case we disregard the packet.
2. It may be marked NEVER; Again we disregard the packet.
3. It may be marked URGENT; Here we save the packet.
4. It may be marked AUTO; Again we save the packet.
5. It may be marked GRAB; We save the packet.

Now if we find the packet meets none of the above criteria then it must be a new entry for the Directory so we check the blockftype entries to see if it to be blocked. In this case we again disregard the packet otherwise we accept it into the directory.

There is some precedence associated with this process.

The directory entry is passed through the select system and checked in the following order: NEVER, AUTO, URGENT. That is, messages which are selected NEVER may be overridden by AUTO which would be overridden by URGENT. This status is stored in SLIST.DAT.

So, we can see that

I) The block_fotype entries are ONLY USED FOR FILES FOR WHICH NO DIRECTORY HAS BEEN RECEIVED. They are a preliminary filter used to stop traffic which you would never ever want.

II) Unless you are really, really sure that you never want to receive a particular type of file, you should not block that type of file.

III) When you receive the directory entry for a file, the select equation system may mark the file AUTO or URGENT even if the file_type is in the block_fotype list.

IV) block_fotype and the select equations do not interact, except that as in (III).

excerpted from Pacsat Software Users Guide
by Dave Hulatt, G4WFQ and Dave Medley, KI6QE

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Release 1, 1st July 1992

APPENDIX C - PG screens and Command Keys

The PG.Screen.

In the latest versions of PG this is a very simple screen, essentially blank, but with a command line along the bottom. This command line should contain three entries QUIT UPLOAD TERMINAL.

To start a function use the first letter of the command, Q U or T. If you press T your machine becomes a dumb terminal.

Just above this Command line you will see something like this:

```
Ready | Pg.exe 920225k | Com1: 19200 | UOSAT5-12 | KI6QE-0
```

The first word will change to WAITING while it is listening for the Open signal from the satellite. You will also see BACKOFF and DISCONNECT. In the main window area you will see the process as it continues. It will tell that you that it has connected, is uploading File xxxx, the satellite responds by accepting the upload and allocating a file number. At the completion of the upload you will see a message giving you the data rate achieved in bytes/sec.

The PB screen.

This is much more complicated than PG. When it loads you will see that it is divided into three Windows, the top half of the screen being divided vertically. The top Left Window we will call File Status, top Right, the Download and the bottom window is Information. At the very top of the screen is the Command Line and at the very bottom is the Status Line. The Command Line will look like this:

```
Download Priority Auto Grab Never Fill Dir Info ViewDir Quit Help
```

With the exception of Download, the first letter of each command is highlighted, meaning it is available. Download is NOT available at this time.

The you will use most is V for View Directory. This will give you a directory listing which can be made selective by the use of the F keys as already discussed above.

While viewing the directory you can mark files, which have not been selected automatically with the commands A (Action) P (Priority) or N (Never). Most of them you will see are marked G (Grab) which means they will be downloaded into your machine if they are heard. Files marked A or P will be requested for Broadcast.

The File Status Window has the following headings:

```
Message   Holes   Size   Offset   Rcvd
```

In this window you will see information about files currently being requested for broadcast and the progress of the operation.

Message is the filename of the file. This is a 4 digit hex number

Holes is the number of holes to be filled before the file is complete

Size is the length of the file in decimal

Offset is the address of where the next broadcast packet will start. (Don't worry about this. Only programmers want to know)

Rcvd. This will be % and means the percentage of the total file already received.

The Download Window will keep you informed as to what is going on. Most of the messages are self evident like "Message 3d22 heard" or "Message 3d22 downloaded" but there may be some more mysterious ones like "Stat Blocked" or "Stat Done" etc.

In the lower window you will see the satellite messages which include the broadcast queue, the BBS Status (BBSTAT) and responses from the satellite. The broadcast queue is simply a list of those stations whose request for broadcast is being processed. The call sign may have a /D after it which means this is a request for Directory. The BBSTAT messages are brief and include "OPEN" and "SHUT" and a list of those stations connected to the satellite. You will also see messages like "OK KI6QE" and "NO -1 KI6QE". These have already been explained above.

On the very bottom of the screen you will see the Status Line which looks something like this:

Dir:Old Auto:Idle s: b: d: e:

The Dir status tells the status of the directory. It will say either Old or Up-to-date.

The Auto entry will show either Idle (I am asleep) or Auto (I am requesting broadcasts) or Off (Manual Mode)

The four entries on the right tell how the download is going and will be constantly changing decimal numbers during a satellite pass.

e will indicate the number of errors (This will be a small number)

d is the number of Directory bytes received. This will be around 100k by the end of a pass.

b is the number of bytes of message content received. This could be as high as 500k after a good pass,

s tells the speed at which you have been receiving data on the downlink, in bytes per second. This is calculated about every five seconds. Thus s:0900 means that you have received 45,000 bytes in the last five seconds.

APPENDIX E - Sample 9600 bps Station Equipment Distribution

Equipment Usage from the UO-22 User's List 1/92

9600 bps satellite user's equipment breakdown

<u>Receivers</u>	<u>Transmitters</u>	<u>Modems</u>	<u>TNC</u>
FT726R 57	FT736 57	G3RUH 100	TNC-2 58
TS790 21	TS790 23	NB96 46	Tiny-2 39
IC471 11	IC275 10	DSP-12 6	MFJ1270 10
FT726 11	IC251 8	homebrew 4	TNC200 10
IC475 10	FT726 7	MFJ9600 2	mPOWER 5
TR851 7	TS711 6	DSP-2232 2	PK-232 4
FT780 6	TR751E 6	K9NG 2	MFJ1278 3
TS811E 6	<6 units each	Data Engine 1	homebrew 3
<6 units each	IC970,IC271,	PacComm 1	PK88 3
IC970,IC451,	FT480,TS700,	DE9600 1	TNC220 3
IC371,IC490,	FT290,FT225,		<3 units each
TS780,FT790,	TR9000,IC475,		MFJ1270b,MFJ1274,
FT712,TR751,	FT227,TR9130,		DRSI,TNC222,
TX790,TS700,	TR9500,TX790,		TNC22,TNC20,PK80,
IC275,IC500,	IC202,IC211,		PK-87,SCC8530,
IC230	IC27,IC290,		FRASH,PAD205,
	IC274,ALINCO112		TNC320,micro2,
	TM221E		Data Engine

Appendix F

Notes on Bits and Bauds and the "PB" Program

A short technical digression by

Vern "Rip" Riportella, WA2LQQ

21Oct93

ABSTRACT: "Bits" and "Bauds" and "CPS" are described and distinguished.

The meanings of various indicators displayed when running the PB.EXE packet satellite earth station program are described.

=====

There is perennial confusion about bps (bits per second or b/s) and bauds among amateurs as well as professionals in the field. When "cps" (characters per second) and wpm (words per minute) are added, the picture gets more confused yet.

This paper clarifies these terms and explains some of the display indicators associated with PB including the PB.LOG record file.

1. Bits, Bauds and Bandwidth

=====

[Following from "Data Transmission"]

[Quote]

TRANSMISSION RATE:

The transmission rate is generally expressed in baud (Bd). Although in most systems it is equivalent to bits per second (b/s), the baud rate must not be confused with information rate, bits per second, the rate at which actual data are transmitted. One baud signal may carry more bits of the data. The following examples are given to distinguish these two concepts.

EXAMPLE 1: In a 9600 b/s system which utilizes QAM (quadrature amplitude modulation) method, the transmission rate is 2400 Bd; i.e., the quantity of discrete signals transmitted in a second is 2400. Since every discrete signal represents a combination of 4 bits, the information or communication rate is 9600 b/s.

EXAMPLE 2: If a one-unit stop and start bit and an eight-level ASCII code are used, the byte becomes 10 bits long. If the transmission rate is 4800 Bd, the actual information rate is $0.8 \times 4800 = 3840$ b/s. Hence 960 b/s is lost due to synchronization. If parity is considered, another 480 b/s is also lost due to parity detection. As a result, 1440 b/s, or 30 percent of the original bits, is not used for carrying information.

Therefore, it can be seen from these examples that the information rate bits per second and the transmission rate baud are not equivalent.

Low-speed transmission rate also has another expression --wpm (words per minute) or cps (characters per second). For example, 100 wpm can mean either 75 Bd using a five-level (7.42 unit) code or 110 Bd using an eight-level-plus three-pulses code. Note that one word equals six characters.

4.1 Channel-Capacity-Increasing Methods on Data Transmission

The Nyquist theorem states that over a band-limited channel at most two independent data pulses per second per cycle of bandwidth can be transmitted. For data transmission over a voice channel, the usable bandwidth is 2400 Hz. This then indicates that a maximum baud rate of 4800 b/s is allowable. To accomplish a 9600 b/s data rate, therefore, 2 bits/Bd must be transmitted.

Unquote [Footnote 1]

2. PB Indicators

=====

[Following from "PB User's Doc"]

[Quote]

The "s:" indicator tells the speed at which you have been receiving data on the downlink, in bytes per second. This is calculated roughly every five seconds. Thus, "s:0900" means that you have received 45000 bytes in the last 5 seconds.

[Editor's note: 900 Bps, Bytes per second, is $900 \times 8 = 7200$ bps, bits per second. This is the information or data rate. The link rate is fixed at 9600 bps (1200 Bps).]

The "b:" counter counts the number of bytes in message broadcast frames you have received since starting PB. This includes all message broadcasts on the downlink, not just those which were important to your station.

The "d:" counter counts the number of bytes in directory broadcast frames you have received since starting PB. This includes all directory broadcasts on the downlink, not just those which were important to your station.

Both the "b:" and the "d:" counter include Broadcast Protocol overhead of about 11 bytes per packet, but they do not include the AX.25 overhead, which is near 18 bytes per frame.

The "e:" indicator counts the number of broadcast message data or directory packets which were corrupted between reception by your TNC and processing by the PB program. "e:" can increase because PB runs too slowly on your PC, because some other TSR program running on your PC is turning hardware interrupts off for too long, or because of faults in your serial cable. You can sometimes tell which by examining the messages printed when PB exits. Do not worry if you get a few "e:" counts during a pass, especially if you are using the directory and message views a lot - keyboard activity can cause missed characters or buffer overruns.

[Unquote]

Optional "q" parameter.

In some experimental PB versions a "q" indicator is also presented on the very bottom of the screen adjacent to "s". This is link "quality" or receive "quotient"; whichever you choose to call it. It represents the percentage of bytes sent from the satellite that you have properly received.

Specifically: $q = Br/Bs \times 100$

where: Br = Bytes received and
Bs = Bytes sent by the satellite.

The ratio of the two gives an indication of the downlink performance, including your station, at that moment.

Thus, the "q" parameter is a quotient indicating the quality of the link to you. An excellent link will produce "q" values of 98 or 100 for most of the pass. The value is updated approximately every 5 seconds.

3. PB.LOG

=====

Regarding the meaning of entries in the PB.LOG, the following is the portion of the PB users doc addressing them.

[Quote]

3.3.3 Througput [sic] Log

When you exit from PB, PB writes a log entry to the file PB.LOG. The entry tells the start and end time of the pass, the maximum downlink throughput reached during the pass (in a 5-second window), the total number of bytes received during the pass, and the downlink throughput [sic] averaged over the entire duration of the pass. An example of a PB.LOG message is shown below.

92/04/29 17:10:41 - 17:10:47 : Max=1222 Bps Gross=1188 Bps Total Bytes=7128

[Unquote]

Several issues require explanation here.

The number of bytes you receive (Total Bytes) depends on how many were sent from the satellite and how many were lost on the way to your PC.

The satellite downlink data rate is not constant. Although the link rate is fixed at 1200 Bps (9600 bps), the information rate is often only half of that (600 Bps). At times the satellite CPU gets busy doing things like directory searches. This tends to slow the rate at which data can be moved

out on the links. You can see this effect as short term variations in the "s" parameter.

"Max" is the peak surge capture RATE where the sample space is 5 seconds.

Although the maximum theoretical value is 1200 Bps ($9600/8 = 1200$), due to sampling window variations, occasional values exceeding 1200 Bps may occur.

The definition of "Gross" as provided above is not exactly the way the program runs. As described above, "Gross" is

$$G = B/T1 \quad \text{where}$$

$B = \text{Total Bytes, and}$
 $T1 = \text{"pass" duration.}$

However, the program actually calculates G as

$$G = B/T2 \quad \text{where}$$

$T2 = \text{total interval PB is running; sample window}$

This discrepancy is caused by the absence in the current PB versions of a detector that senses when a satellite pass is in progress. So PB simply uses the start/stop time of PB to calculate the "Gross" value.

The practical result is that the value of "Gross" that is logged by PB.LOG depends on how long you let PB run, when you run it, as well how many bytes you captured during the run. If you leave PB running for long periods with no satellite in view, the "Gross" value will become progressively lower.

That is, where:

$$G = B/T2,$$

if B is held constant while T2 increases, G (Gross) decreases.

For example, if you leave PB running for 24 hours, you might see a "Gross" value of 66 Bps. However, if you start PB at AOS and end PB at LOS (such that $T1 = T2$), the "Gross" value will then ACTUALLY be the performance averaged over a pass, say in the range of 400 Bps to 600 Bps.

The overall result is that the value of "G" can vary by a significant degree depending on how the sample is made, i.e., how long you let PB run.

Here are several examples of how and why the G value can vary widely.

A) If the sample period ($T2$) is short and occurs during a pass, then G will vary widely depending on short term effects like CPU load and QRM local to you.

B) If the sample period is equal to pass duration (i.e., $T2 = T1$), G will accurately represent the average data rate during the pass. The pass-to-pass variations in G will tend to be slight and you

should see values in the 500 - 600 Bps range.

C) If the sample period extends beyond the pass duration ($T_2 > T_1$), G values will become less.

D) If T_2 is very long, G will continue to decay with time approaching a certain value as an asymptote or limit, (L). The value of L for a given satellite varies with daily access time which in turn varies with latitude of the earth station.

For example, calculate the Average Daily Access Time [4] to KO-23. For a station in New York at 41 deg N, ADAT is 8726.4 seconds per day. [5] This represents a 10.1% probability (P) of finding the satellite in view at a NY QTH at any randomly chosen instant. [6]

The limit, L, will then simply be the average of the short term averages ("s" parameter) multiplied by P, the probability of the satellite being in view.

$$P \bar{X}_s = L$$

Casual observation suggests "s" tends to hover around 600 Bps. If we take $P = 0.101$, then a L of 60.6 Bps should be expected.

In fact, when we have left PB running for long periods, the G value does seem to converge in the 60's.

=====
Footnotes:

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[1] Tugal and Tugal, "Data Transmission" Second Edition, McGraw-Hill, 1989, pp 133-134.

[2] PB User's Doc, version 0.03, Jeff Ward, G0/K8KA, 4-30-92, para 3.3.1

[3] Ibid, para 3.3.3

[4] Term, analysis, computational technique and BASIC program devised by Dr. Martin Davidoff, K2UBC. "An Efficient Method For Calculating Average Daily Access Time". Paper presented to the AMSAT-UK 5th Colloquium, Univ.Surrey, 26-29Jul90.

[5] Horizon defined as 0 deg elevation, no diffraction and no marginal zones; a "silver wall" horizon.

[6] $8726/86400 = 0.101$ There are 86,400 seconds per 24 hour day.

APPENDIX G

Sample log files for AO-16

94/03/01	16:22:27	-	17:00:09	:	Max=172 Bps	Gross= 39 Bps	Total Bytes=90003
94/03/02	03:45:00	-	03:45:01	:	Max= 0 Bps	Gross=695 Bps	Total Bytes= 695
94/03/02	03:45:13	-	04:57:50	:	Max=155 Bps	Gross= 8 Bps	Total Bytes=38997
94/03/02	15:56:24	-	16:09:55	:	Max=168 Bps	Gross= 67 Bps	Total Bytes=55048
94/03/02	17:32:57	-	17:46:52	:	Max=159 Bps	Gross= 72 Bps	Total Bytes=60833
94/03/03	04:58:26	-	04:58:27	:	Max= 0 Bps	Gross=510 Bps	Total Bytes= 510
94/03/03	04:58:41	-	05:12:22	:	Max=153 Bps	Gross= 19 Bps	Total Bytes=16397
94/03/04	02:52:43	-	02:52:44	:	Max= 0 Bps	Gross=558 Bps	Total Bytes= 558
94/03/04	02:52:57	-	02:54:42	:	Max= 51 Bps	Gross= 4 Bps	Total Bytes= 510
94/03/04	04:18:57	-	04:42:06	:	Max=172 Bps	Gross= 64 Bps	Total Bytes=89923
94/03/08	16:28:57	-	16:36:13	:	Max=160 Bps	Gross= 65 Bps	Total Bytes=28565
94/03/08	18:00:37	-	18:20:40	:	Max=168 Bps	Gross= 51 Bps	Total Bytes=61588
94/03/10	04:47:01	-	04:47:02	:	Max= 0 Bps	Gross=255 Bps	Total Bytes= 255
94/03/10	04:47:14	-	06:51:34	:	Max=165 Bps	Gross= 8 Bps	Total Bytes=65445
94/03/10	17:09:23	-	17:14:56	:	Max=153 Bps	Gross= 60 Bps	Total Bytes=20116
94/03/12	05:27:18	-	05:40:02	:	Max=160 Bps	Gross= 93 Bps	Total Bytes=71526
94/03/14	16:44:12	-	17:00:17	:	Max=153 Bps	Gross= 81 Bps	Total Bytes=78344
94/03/16	15:47:13	-	16:07:12	:	Max=153 Bps	Gross= 40 Bps	Total Bytes=48957
94/03/17	04:42:19	-	05:05:23	:	Max=160 Bps	Gross= 60 Bps	Total Bytes=83848
94/03/19	02:10:29	-	03:04:54	:	Max=158 Bps	Gross= 10 Bps	Total Bytes=34918
94/03/19	05:24:56	-	05:24:57	:	Max= 0 Bps	Gross=332 Bps	Total Bytes= 332
94/03/19	05:25:09	-	05:42:27	:	Max=159 Bps	Gross= 49 Bps	Total Bytes=51011
94/03/21	02:54:05	-	03:00:04	:	Max=164 Bps	Gross= 97 Bps	Total Bytes=35095
94/03/22	03:56:36	-	04:33:07	:	Max=169 Bps	Gross= 38 Bps	Total Bytes=84277
94/03/22	16:19:21	-	16:29:38	:	Max=153 Bps	Gross= 61 Bps	Total Bytes=38046
94/03/26	17:36:34	-	17:49:16	:	Max=157 Bps	Gross= 98 Bps	Total Bytes=75117
94/03/28	18:22:29	-	18:30:41	:	Max=153 Bps	Gross= 79 Bps	Total Bytes=39128
94/03/30	03:24:37	-	03:42:01	:	Max=176 Bps	Gross= 79 Bps	Total Bytes=83165
94/04/02	05:17:20	-	06:04:34	:	Max=169 Bps	Gross= 24 Bps	Total Bytes=68912
94/04/06	03:27:21	-	03:37:08	:	Max=181 Bps	Gross= 82 Bps	Total Bytes=48190
94/04/06	05:01:09	-	05:01:15	:	Max= 42 Bps	Gross= 42 Bps	Total Bytes= 255
94/04/06	05:01:27	-	05:15:54	:	Max=163 Bps	Gross= 93 Bps	Total Bytes=81038
94/04/07	02:54:12	-	02:54:13	:	Max= 0 Bps	Gross=255 Bps	Total Bytes= 255
94/04/07	02:54:30	-	03:03:38	:	Max=170 Bps	Gross= 90 Bps	Total Bytes=49640
94/04/11	14:55:31	-	15:13:08	:	Max=162 Bps	Gross= 26 Bps	Total Bytes=27530
94/04/13	04:55:14	-	05:36:12	:	Max=163 Bps	Gross= 28 Bps	Total Bytes=70240
94/04/14	04:30:29	-	04:43:55	:	Max=161 Bps	Gross= 78 Bps	Total Bytes=63074
94/04/14	16:47:26	-	16:57:53	:	Max=175 Bps	Gross= 77 Bps	Total Bytes=48310

Sample log files for k0-25

93/09/15	00:28:31	-	00:49:03	:	Max= 969 Bps	Gross=645 Bps	Total Bytes=794878
93/09/15	16:56:46	-	17:08:59	:	Max= 969 Bps	Gross=710 Bps	Total Bytes=521126
93/10/04	22:16:23	-	22:36:29	:	Max= 969 Bps	Gross=581 Bps	Total Bytes=700781
93/10/28	15:22:51	-	15:47:28	:	Max=1020 Bps	Gross=296 Bps	Total Bytes=438092
93/11/07	06:23:07	-	06:43:34	:	Max= 969 Bps	Gross=489 Bps	Total Bytes=600548
93/11/17	03:16:02	-	03:36:24	:	Max= 918 Bps	Gross=581 Bps	Total Bytes=710962
93/11/27	00:14:10	-	00:32:28	:	Max= 918 Bps	Gross=444 Bps	Total Bytes=488064
93/12/02	01:41:31	-	01:58:42	:	Max= 918 Bps	Gross=442 Bps	Total Bytes=455733
93/12/14	05:15:41	-	05:27:24	:	Max= 969 Bps	Gross=568 Bps	Total Bytes=399424
93/12/16	20:06:42	-	20:25:10	:	Max= 931 Bps	Gross=521 Bps	Total Bytes=577706
93/12/16	22:04:05	-	22:20:45	:	Max= 876 Bps	Gross=437 Bps	Total Bytes=437521
94/01/02	23:06:26	-	23:13:35	:	Max= 867 Bps	Gross=426 Bps	Total Bytes=183115
94/01/04	15:41:47	-	15:59:02	:	Max= 919 Bps	Gross=432 Bps	Total Bytes=448060
94/02/21	07:34:23	-	07:54:43	:	Max= 969 Bps	Gross=601 Bps	Total Bytes=733666
94/02/28	05:38:14	-	06:00:28	:	Max=1020 Bps	Gross=507 Bps	Total Bytes=676639
94/04/14	04:44:57	-	05:00:21	:	Max= 918 Bps	Gross=605 Bps	Total Bytes=559193
94/04/15	03:01:04	-	03:19:15	:	Max=1071 Bps	Gross=480 Bps	Total Bytes=523871

APPENDIX H SAREX

Sample SAREX information made available via standard AMSAT message routes for each shuttle mission with amateur radio activity. The mission data will change, but frequencies should stay the same. Try listening to the shuttle audio link on HF, it is quite interesting.

SB SAREX @ AMSAT \$STS-59.002
STS-59 SAREX Flt Info

Launch of next SAREX mission imminent

The next Shuttle Amateur Radio Experiment (SAREX) mission is ready for launch at the Kennedy Space Center in Florida. This flight, designated STS-59, is scheduled for launch on Friday April 8 at 12:06 UTC. Weather conditions could cause the launch to move forward or back by one hour. STS-59 will carry Jay Apt, N5QWL and Linda Godwin, N5RAX on a nine day mission which will include packet radio and some voice operations. A SAREX fact sheet, courtesy of Jay Apt, the ARRL and AMSAT follows. Note that during this mission, the JSC ARC, W5RRR, expects to retransmit NASA Select audio on AO-13. The planned downlink frequency will be 145.84 MHz. In addition the JSC ARC crew in Houston have set up a dial-in BBS which is now in operation. Orbital elements will be available on this machine throughout the mission. The phone number for the BBS is (713) 244-5625. Please use 9600 baud or less.

SAREX FACT SHEET - STS-59

WHO: Space Shuttle Endeavour crew

WHAT: Talk via Amateur Radio with students and radio amateurs on Earth.

WHERE: Earth Orbit. Altitude 220 kilometers, with radio coverage in latitudes from 70 degrees North to 70 degrees South. This flight is in one of the lowest altitude orbits ever flown by the shuttle, so pass times will be shorter than usual.

OPERATORS: Dr. Jay Apt (N5QWL) and Dr. Linda Godwin N5RAX.

N5QWL is the commander of the Blue Shift aboard Endeavour and will operate the shuttle systems during the "night" shift, while N5RAX is the Payload Commander, responsible for overall operation of three large radars in the shuttle's cargo bay during the "day" shift.

WHEN: April 8, 1994 at 12:06 UTC (9 day mission)

WHY: As part of the Shuttle Amateur Radio EXperiment (SAREX) component of the STS-59 mission.

SPONSORS: The American Radio Relay League (ARRL), The Radio Amateur Satellite Corporation (AMSAT) and The National Aeronautics and Space Administration (NASA).

SAREX MODES: FM Voice and Packet
VOICE CALL SIGNS: N5QWL and N5RAX
PACKET CALL SIGN: W5RRR-1

SAREX RADIO FREQUENCIES:
Voice Downlink: (Worldwide) 145.55 MHz
Voice Uplink: 144.91, 144.93, 144.95, 144.97, 144.99 MHz

Voice Uplink: (Europe only) 144.70, 144.75, 144.80 MHz
Packet Downlink: 145.55 MHz
Packet Uplink: 144.49 MHz

Successful QSOs on voice will be facilitated by using standard international phonetics for your call sign. The crew not answer any stations using non-standard phonetics. Use your entire call sign -- the crew logs with an audio tape recorder. Do not use the Shuttle call sign -- passes are very short, and the crew wants to work as many folks as possible.

If you can, decrease your radio's deviation to 3 KHz (most are initially set at 5 KHz) and compensate for the Doppler shift. If you cannot, wait until a minute or 90 seconds after the Shuttle comes over your horizon to transmit -- that will put you within the SAREX IF. The above applies to both voice and packet.

INFORMATION: Goddard Amateur Radio Club, Greenbelt, MD, WA3NAN. SAREX news and NASA Mission audio retransmissions on 3.86, 7.185, 14.295, 21.395, and 28.65 MHz and on VHF at 147.45 MHz.

Johnson Space Center Amateur Radio Club, Houston, TX, W5RRR.
SAREX news bulletins on HF bands at 3.850, 7.227, 14.280, 21.350, and 28.400 MHz and VHF at 146.64 MHz.
Also 145.84 on AO-13 at times

ARRL, Newington, CT, W1AW.
SAREX news bulletins (9:45 PM, 12:45 AM EST) on HF bands at 3.99, 7.29, 14.29, 18.16, 21.39, 28.59 and VHF at 147.555 MHz.

PARTICIPATING SCHOOLS:

Ealy Elementary School, West Bloomfield, MI
Kanawha Elementary School Davisville, WV
Alcatel Amateur Radio Association and Circle 10 Council-BSA
Richardson, TX
Anthony Elementary, Anthony, KS
St. Bernard High School, Playa Del Rey, CA
Country Club School, San Ramon, CA 94583
Deep Creek Middle School, Baltimore, MD 21221
Paltamo Senior High School, Paltamo Finland
Ogilvie School, Northampton, Western Australia

OPERATIONS NOTES:

If you have a packet QSO number issued to you by the robot, don't try to get another one! The on-board program drops the duplicates anyhow, and all you are doing is making it harder for the other folks. A QSL card will be issued if you appear in the "heard" list on the TNC.

N5QWL will be asleep over most USA passes, and N5RAX will be busy with assigned duties for most daylight US passes, so if the sun is up, try SAREX on packet. The Shuttle crew will try to work voice (1) when we are not otherwise engaged, and (2) at night or when the ground is cloudy (we are generally busy taking pictures of the Earth during clear daylight passes).

If Jay Apt can get to it, he will activate the SAREX about 3 hours into the mission.

QSL via: ARRL, ATTN: STS-59 QSLs, 225 Main Street, Newington, CT 06111, USA. Include a self-addressed stamped envelope (SASE). Non-US stations include a self addressed envelope with \$0.50 of US postage affixed or appropriate IRCs. Include the Callsign worked, Date, UTC, Mode, and Frequency. For packet contacts, include the QSO number issued by the robot. SWL QSL's: Include the Callsign heard, Date, UTC, Mode, and Frequency.

STS-59 Keplerian elements for a 12:06 UTC launch:

```
STS-59
1 00059U          94098.74878017  .00221188  00000-0  11303-3 0      80
2 00059  57.0053 277.0416 0009259 269.9963  90.0094 16.19806752    54
```

Sample SAREX operation as captured WB5ZIB

W5RRR-1>SAREX [04/12/94 10:11:40] <UI>:
This is STS-59 SAREX Robot station W5RRR-1
onboard the Space Shuttle Endeavour.

c w5rrr-1
cmd:*** CONNECTED to W5RRR-1 [04/12/94 10:12:07]
#1319-is your STS-59 SAREX QSO number.

*** DISCONNECTED [04/12/94 10:12:12]

W5RRR-1>WA7SFL [04/12/94 10:12:28] <UA>
W5RRR-1>WA7SFL [04/12/94 10:12:29] <I S0 R0>:
#1320-is your STS-59 SAREX QSO number.

W5RRR-1>WA7SFL [04/12/94 10:12:34] <I S0 R0>:
#1320-is your STS-59 SAREX QSO number.

W5RRR-1>WA7SFL [04/12/94 10:12:34] <UA>
W5RRR-1>WA7SFL [04/12/94 10:12:38] <I S0 R0>:
#1320-is your STS-59 SAREX QSO number.

W5RRR-1>WA7SFL [04/12/94 10:12:50] <UA>
W5RRR-1>N4ZQ [04/12/94 10:13:03] <UA>
W5RRR-1>N4ZQ [04/12/94 10:13:04] <I S0 R0>:
#1321-is your STS-59 SAREX QSO number.

W5RRR-1>N4ZQ [04/12/94 10:13:10] <I S0 R0>:
#1321-is your STS-59 SAREX QSO number.

W5RRR-1>N4ZQ [04/12/94 10:13:10] <UA>
W5RRR-1>N4ZQ [04/12/94 10:13:13] <I S0 R0>:
#1321-is your STS-59 SAREX QSO number.

W5RRR-1>N4ZQ [04/12/94 10:13:18] <I S0 R0>:
#1321-is your STS-59 SAREX QSO number.

W5RRR-1>WA0ATE [04/12/94 10:13:33] <UA>
W5RRR-1>WA0ATE [04/12/94 10:13:33] <I S0 R0>:
#1322-is your STS-59 SAREX QSO number.

W5RRR-1>QSL [04/12/94 10:13:37] <UI>:
WA5ZIB/1319 OH2BNH/1293 SM2LRH/1289 OH6UW/1287 KP4BJD/1269 WP4IIW/1268
VK3OF/1264 HS0TA/1259 HS1JC/1258 HS1CES/1257 VK8CR/1231 RK6LWZ/1223
SM5IDM/1218 OK1DWJ/1215 F1JEK/1209

W5RRR-1>SAREX [04/12/94 10:13:38] <UI>:
This is STS-59 SAREX Robot station W5RRR-1
onboard the Space Shuttle Endeavour.

W5RRR-1>KB8PGL [04/12/94 10:13:43] <UA>
W5RRR-1>KC4YAU [04/12/94 10:13:43] <UA>
W5RRR-1>QRZ [04/12/94 10:13:45] <UI>:
#876-KC4YAU KB8PGL WA0ATE N4ZQ WA7SFL WA5ZIB VK6ZBD VK6VL RA6LV SM5VCK
OH6AAD OK2BUH OH4KJY SM5UFB OH6YW SM5BVF OZ6PU PA0BJE OH9NGW OZ4UI OH5NN
OH6UW OH2BNH G0LAM SM5IDM G6IBP SM2LRH ON1APG OZ9AEH G3CAG ON4BT PA3DCO
ON1CAU F1DRE G4RES

...
W5RRR-1>KB8PGL [04/12/94 10:13:57] <I S0 R0>:
#1323-is your STS-59 SAREX QSO number.

W5RRR-1>KC4YAU [04/12/94 10:13:58] <I S0 R0>:
#1324-is your STS-59 SAREX QSO number.
Sample SAREX operation as captured WB5ZIB continued

W5RRR-1>SAREX [04/12/94 10:13:59] <UI>:
#1322-is your STS-59 SAREX QSO number.

W5RRR-1>QST [04/12/94 10:14:01] <I S4 R0>:
Thanks to all of you hams who have connected to our packet station
and worked us on voice! It really makes us feel closely connected
to the people and places that we are flying over.
On board Endeavour things are working very well - the
W5RRR-1>QST [04/12/94 10:14:03] <I S5 R0>:
scientists
are very happy with the data they are acquiring. I am very happy to
be back in space, and it all feels very familiar and nice. Our
crew has been very well trained, and we were able to accomplish
all our tasks as scheduled
W5RRR-1>QST [04/12/94 10:14:04] <I S6 R0>:
so far. We have had some spectacular
views of Earth - we just flew over Tahiti, for example.
73, N5QWL
12 April 1994 02:20 UTC

W5RRR-1>QST [04/12/94 10:14:04] <I S7 R0>:

=====
HR AMSAT NEWS SERVICE BULLETIN 099.01 FROM AMSAT HQ
SILVER SPRING, MD APRIL 9, 1994

New Landline BBS Provides STS-59 SAREX Information

The Johnson Space Center Amateur Radio Club has set up a telephone computer
bulletin board (BBS). The purpose of the BBS is to provide a source of
current Space Shuttle mission Keplerian Elements.

There are limited number of BBS files available for downloading. Among the
current files are:

- o Current and old element sets for the mission in progress
- o Current mission information
- o Shuttle Amateur Radio Experiment (SAREX) information
- o Recent Space Shuttle Mission Schedules and Manifests
- o Astronaut/Cosmonaut Ham List
- o Current JSC Amateur Radio Club Newsletter

We ask that no files be uploaded to the BBS. The telephone number is (713) 244-5625. Our modem can handle all bauds up to and including 9600 baud. The parameters are N-8-1.

The BBS is currently running in ProComm HOST mode, so the logon is very simple and downloading is easy. After logging in, you will see the Welcome Screen describing the BBS. Also, the Welcome Screen contains the current and latest element set number (e.g., JSC008) loaded on the BBS. Check it against your last set so you won't waste your time duplicating a set you already have. Press ENTER to bring up the second page containing the current Space Shuttle Keplerian Element Set. If you have a file capture or screen capture function in your communications software, then you should use it for this page. That way, you won't have to go through the file download process if all you wanted was the latest element set. If you have any comments for the Club or BBS sysop, leave a message and we will respond.

MIR

Mir Operating hints:

a) Since Mir's 'footprint' covers such a broad area and includes so many potential hams, it is necessary that you DO NOT transmit unless you hear the satellite. If you hear the cosmonauts taking with someone, wait until the cosmonauts have signed. Doing otherwise you will only disrupt their reception and cause the QSO to last longer. Not to mention the fact that you are making it unpleasant for the cosmonauts with the QRM you generate.

b) The cosmonauts stay on Moscow time while in space. Their schedule calls for them to sleep from 11 pm to 8 am. This is 2000 to 0500 UTC, so don't expect activity during this time. I have found the period from 1800 to 2000 UTC to be the most active for voice operations.

c) Long connect attempts to the PBBS aboard Mir just cause unnecessary collisions. Check the loading of the satellite PBBS, if activity is heavy wait for the next pass. This will make it easier for all concerned. I have been known to get up and connect at 4 am to avoid the crowds, and even then there are others on.

d) Mir's main FM uplink/downlink frequency is ==> 145.55 MHz

Packet operation with Mir:

The packet equipment aboard Mir changes, but was an ICOM IC-228A 2 meter FM transceiver, a PacComm Handi Packet unit and a laptop computer. Packet operation aboard Mir began in January of 1991. New software for the packet unit that allows up to 10 simultaneous connects is now in place. The astronauts have requested that messages sent to them contain NEWS or interesting items rather than simple hello messages. Note that hearing the packets well does not mean that they are decoded error free. Also remember that a doppler shift is taking place, so try to keep the signal tuned in. Turning on the TNC TRACE command will show you what you are receiving, but with errors.

Sample Mir packet receptions:

```
26-Feb-91 09:40:43 *** CONNECTED to U2MIR-1
Logged on to U2MIR's Personal Message System
```

```
CMD(B/H/J/K/KM/L/M/R/S/SR/V/?)>
```

```
Subject:
```

```
Message:
```

```
Message saved as Msg # 137
```

```
CMD(B/H/J/K/KM/L/M/R/S/SR/V/?)>
```

Msg #	Stat	Date	Time	To	From	@ BBS	Subject
137	P	91/02/26	18:39	U2MIR	N5ITU		Greetings from Dallas Remote
136	PR	91/02/26	18:34	U2MIR	VE7DOX		hello again
135	PF	91/02/26	16:09	KJ9U	U2MIR		scd
134	PR	91/02/26	13:39	U2MIR	KJ9U		list
133	PR	91/02/26	13:38	U2MIR	NH6QT		Hello MUSA
132	PR	91/02/26	13:37	U2MIR	KJ9U		hello, need confirmation

13607 Bytes free
Next message Number 138

CMD(B/H/J/K/KM/L/M/R/S/SR/V/?)>

YOU CANNOT READ THIS MESSAGE

26-Feb-91 09:49:43 *** DISCONNECTED: U2MIR-1

Mir PBBS Command Summary **PMS (PacComm Personal Message System)**

U5MIR-1>CQ:

CMD(B/H/J/K/KM/L/M/R/S/SR/V/?)>

- B**(ye) B [CR] disconnects you from PMS.
- H**(elp) H [CR] or ? [CR] displays this general command description file.
- J**(log) J [CR] displays a list of callsigns heard (optional date/time).
- K**(ill) K n [CR] deletes message number (n) (only to/from your callsign).
- KM**(ine) KM [CR] (Kill Mine) deletes all READ messages addressed to your callsign.
- L**(ist) L [CR] lists the 10 latest messages.
- M**(ine) M [CR] lists the 10 latest messages to/from your callsign.
- R**(ead) R n [CR] reads message number n.
- S**(end) S (callsign) [CR] begins a message addressed to (callsign).
 Subject: max 28 characters ending with [CR].
 Text:End each line with [CR].End message by typing /ex[CR] or CTRL-Z[CR]at
 the beginning of a new line.
- SR**(epl)y SR n [CR] Sends a reply to message n prompting only for text.
- V**(ersion) V [CR] displays the software version of the PMS system.
- ?** ? [CR] displays this help file.

* * * * *

FO-20

FO-20 operates in two distinct modes, JA and JD. Mode JA is for analog operation (CW/Phone) using the mode J bandplan. Mode JD is a digital mode used for operation of the PBBS, also using the mode J bandplan. The mode J bandplan is amateur satellite terminology for a 2 meter(145 MHz) uplink and a 70cm(430 MHz) downlink.

Each of the FO-20 modes(JA and JD) uses a separate transponder, so both modes can be operational simultaneously. Since the necessary equipment and operation of each mode is so different, mode JA and JD will be described separately. The analog mode is the simpler of the two on which to become operational, so we will begin with FO-20 Mode JA. Currently there is no published mode schedule for FO-20. It is up to the operator to determine what mode or if both modes are operational when the satellite is in view. This is done by looking for an active beacon signal.

Mode JA beacon - 435.795 MHz, CW and 1200 bps PSK, AX.25

Mode JD beacon - 435.912 MHz, 1200 bps PSK, AX.25

Operating FO-20 Mode JD

Uplink power required: 100 watt ERP
35 - 40 watts * 3 dB vertical - coax loss or
10 watts * 12 db beam - coax loss

Mode JD (Mode J PSK digital)

Full duplex store and forward packet using 1200 bps Bi-phase Manchester code and AX.25 protocol. You simply choose one of the uplink frequencies and connect to 8J1JBS.

uplink 145.850, 145.870, 145.890, 145.910 MHz FM

downlink 435.912 MHz SSB

Make sure your TNC has: FULLDUPLEX ON
FRACK 6 (minimum 6)
MAXFRAME 2 (maximum 3)
optional: MONITOR ON to monitor others

To connect: C 8J1JBS

When connected you will get this prompt:

8J1JBS>WA4SXM:FO-20/JAS1b Mailbox ver. 2.00

commands [B/F/H/M/R/U/W]

Use H command for Help

Commands: B - List file headers addressed to ALL
F - List 15 file headers
F* - List latest 50 file headers
F<d> - List file headers posted on day <d>
H - Help -- Show this message
K<n> - Kill a file numbered <n>
M - List file(s) addressed to current user
R<n> - Read file(s) numbered <n>
U - Users -- list current users
W - Write file(s)

Normally the user will enter the 'M' command first to see what personal messages are waiting. The F command will list the latest 15 messages. Then use the 'R file#<,file#>' command to read the selected file(s).

FO20 Mode JD BBS Command Description

All file headers use the same format: NO., DATE, UTC, FROM, TO, SUBJECT.

The NO. is the reference number for the file that is used with the Read and Kill commands. The DATE and UTC are the date and time the message was posted on the Mailbox. The FROM, TO and SUBJECT are self explanatory. It is good operating practice to Kill all messages addressed to you after they have been read.

B command -> Lists the file headers addressed to ALL

NO.	DATE	UTC	FROM	TO	SUBJECT
0235	05/08	21:07	SM0TER	ALL	MODE J FILTER INFO
0223	05/08	17:25	ON6UG	ALL	JD - USERS (4)
0212	05/08	11:42	JE2CKG	ALL	CQ
0205	05/08	10:14	IV3TKI	ALL	KEPLER * 280490
...					
0134	05/07	13:18	JH1ADY	ALL	HELLO

F command -> F = Files, the lastest 15 files are shown the first time F is invoked. Subsequent F commands will display the previous 15 messages. A message with * appended to the 'To:' field has been addressed to multiple users.

NO.	DATE	UTC	FROM	TO	SUBJECT
0240	05/08	21:12	PA3DVG	DL1CF	post
0239	05/08	21:12	IV3TKI	ON6UG	MY RYG
0237	05/08	21:10	PA3DVG	WB6LLO	post
0236	05/08	21:08	PA3DVG	EA6IC	post
0235	05/08	21:07	SM0TER	ALL	MODE J FILTER INFO
0233	05/08	19:10	DL1CF	CE3XK	Hello from DL
0232	05/08	19:08	DL1CF	9H1EY	Hello from DL
...					
0223	05/08	17:25	ON6UG	ALL	JD - USERS (4)

H command -> H = Help!

B	- List file headers addressed to ALL
F	- List 15 file headers
F*	- List latest 50 file headers
F<d>	- List file headers posted on day <d>
H -	- Help -- Show this message
K<n>	- Kill a file numbered <n>
M	- List file(s) addressed to current user
R<n>	- Read file(s) numbered <n>
U	- Users -- list current users
W	- Write file(s)

M command -> M = Mine, lists the latest 10 messages to/from the current user. Used to save channel time when the user only wants his messages.

NO.	DATE	UTC	FROM	TO	SUBJECT
0247	05/09	02:15	LU1EXC	LU7XAC	chiche
0242	05/09	00:24	LU6DYD	LU7XAC	SIMPOSIO

R command -> R <file#1>,<file#2>,...,<file#7>,<file#8>

R = Read, specifies up to 8 files to be read. The file numbers are found by monitoring when someone else lists the files or by using the F or M command.

```

0288 05/10 19:50 ON6UG ALL JD - USERS (4)
MODE JD USERS LIST COMPILED FROM USERS DATE MAY 10,1990 PAGE 4
Please use this format to add your station. Thnx.
CALL ! NAME ! MODEM ! TNC ! MAILBOX ! ANT dwnlnk ! ANT uplnk ! Track syst
-----
WB6GFJ ! ROSS ! G3RUH ! PK232! N6IIU !2xKLM18C !2xLKM14C !IT/KCT
I3RUF ! Gino ! JS1UKR!TNC320! none ! 21 elem H ! 16 elem H !GRTRAK-auto
SM5BVF ! HENRY ! G3RUH !TINY-2! SM0ETV ! 13 EL XY !6 EL XY !MANUAL
W6SHP !Howard ! Tapr !PK232 ! WD6CMU ! KLM 18C ! 2x17 Elem.H! IT-MANUAL
G8TZJ !Andrew ! G3RUH !Tiny-2! GB7BPL ! 17 el XY ! 6 el XY ! H/B
WA4SCA ! Alan ! TAPR ! PK-80! W4HHY ! KLM 40CX ! KLM 22C ! QT/KCT
WB6HHV ! Mike ! Danet 12M ! AA6QN ! CC 416TB ! CC A144-20T! IT/KCT
DL6KG ! HANS ! G3RUH !TNC-2 ! DB0CZ ! 48 elem H !2x9 el circ !GRTRAKauto
HB9MGI ! Ernst ! G3RUH !PK232 ! HB9AC ! 17 el. xy ! 10 el. xy ! Manual
SM0TER ! BRUCE ! G3RUH !TNC-2 ! SM0ETV ! 2X14 XY ! 2X9 XY ! HOMEB 8052
KD2CQ !Rich ! Tapr !MF1270! None ! Klm 18C ! KLM 14c ! manual
IW1BMJ !CLAUDIO !Homemad!TNC-2 ! None ! 21 Elem. H ! 2x17 Elem.H! IT-manual
IV3TKI ! ALDO ! G3RUH ! TNC-2! IV3PFF ! 2X10 XY ! 4X20 XY ! IT/MAN

```

Please send your info in ABOVE FORM (pse) TO ON6UG in FO-20 73's Freddy
 If you need file 1,2 and 3 send a message via FO20.Updates only in file (4) !
 * next to file means FINAL (will not be updated anymore)
 if your info is lost pse try again ! 73's Freddy

U command -> Users, lists the last 11-15 users connected, oldest first

```
8J1JBS>W9FMW:DC7PK -0 JA3XCZ-0 JA0ENG-0 HC2FG -0 SM0TER-0 CE3XK-0 W9FMW -  
0 WB0KSL-0 WB6GFJ-0 KI6QE -0 PA3DVG-0
```

W command -> W [call#1,call#2,...,call#7,call#8]

W = Write, can specify up to 8 stations to receive the message. The call field is optional, if it is not specified (CR entry) then the message is addressed to ALL (you will be prompted with a TO:, just type a CR. The mailbox then prompts the user to enter the subject of the message by sending "Subj:". The user may type up to 32 characters, terminated with a CR. The 'Text:' message appears next. This prompts the user to enter the data. Commonly used text, like station equipment, international greetings, and CQ calls may be created as an ASCII file and uploaded via the terminal program, in lieu of typing the text. Type the text as normal, ending each line with a CR. To terminate the text enter either a <CR>.<CR> or a <CR><CTRL/Z><CR> sequence. The mailbox will respond with an END reply.

```
cmd: W <cr>
```

```
8J1JBS>WA4SXM:TO?
```

```
G8TZJ<cr>
```

```
8J1JBS>WA4SXM:SUBJECT?
```

```
first FO-20 message <cr>
```

```
8J1JBA>WA4SXM:Enter text, <CR>.<CR> to end.
```

```
Hello Howard from Gould in Knoxville, TN. This is my first FO-20 message.  
This mode offers exciting possibilities for worldwide message passing and  
meeting new hams. <cr>
```

```
73, Gould <cr>
```

```
<cr>.<cr>
```

```
8J1JBS>WA4SXM:END
```